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Comparison of Response Interruption and Redirection, Variable Ratio RIRD, and Signaled RIRD for Stereotypy in Children Diagnosed With ASD

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Comparison of Response Interruption and Redirection, Variable Ratio RIRD, and Signaled RIRD for Stereotypy in Children Diagnosed With ASD

By

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Dissertation

Presented to the Faculty of the Graduate School of

The University of Texas at Austin

in Partial Fulfillment

of the Requirements

for the Degree of

Doctor of Philosophy

The University of Texas

May 2019

DEDICATION

I dedicate this dissertation to a few influential teachers and professionals throughout my years. First and foremost, to my 1st grade teacher, Beverly Bryan. You went beyond the classroom and didn't just provide me with an education, but provided me with the love, care, and nurturing I needed during a difficult time in my childhood. You instilled in me a love for learning at a young age that has never left me.

To Mrs. Waters, my 6th grade speech teacher. I hated you, I hated getting up in front of the class and talking, I hated the topics I had to speak on, and I just overall hated the entire class. In class, despite my excessive absences, you pushed me to get past the fear and anxiety and do it anyway. You pushed me to discuss the difficult things I didn't want to discuss. You pushed me to tell others the things that most mattered to me and to fight for what I believe in no matter how scared or anxious I became. You taught me that my words have power. For that I am forever indebted to you because over the years my words have been my power. I became the best at giving speeches and presentations in my classes due to the lessons you instilled in me about talking in front of people all those years ago. These skills are what have gotten me to this point today and I am always grateful.

To Mrs. Dozier, my high school AP English teacher. Thank you for ripping apart my writings and making all my papers bleed. Thank you for teaching me how to write actively. Thank you for being honest and not afraid to let me know what you truly thought about my writings. You are the reason I was able to effectively write and receive so many scholarships and fellowships over the years to help fund my last decade of college.

To Mrs. Dorsey, my high school childcare teacher. You cried with us, laughed with us, pushed us, taught us, and most importantly loved us. I spent half of the school day in your class for two years and learned more from you than words could ever explain. You taught me to be more positive with children and that being positive can have a better impact than saying and doing things negatively. You called me out for my nonsense and pushed me to be the best that I could be. You instilled the basic skills in me that I needed to become a behavior analyst and are the reason I have excelled in my career working with children.

To Mrs. Blackmon, my high school yearbook teacher. You, much like Beverly Bryan, affected my life well beyond the classroom. You made me feel important in yearbook and in life. You helped me realize I was worth something to somebody and I could achieve anything I set my mind to. You lent me the yearbook couch at night when I emotionally wasn't ready to go home, you let me miss classes to stay in your room and catch up on work or sleep when I needed it the most, you taught me valuable lessons in life, and you encouraging me to push forward and raise children to the best of my ability despite my young age. For that I can never repay you.

To Cari Harker-Henry, one of my BCBA supervisors. You were more than just a supervisor. You were a mother figure. A teacher. A counselor. A friend. A true all-around Mama Llama! Though we would butt heads often due to YOUR stubbornness, you taught me life lessons I will never forget. You cared for me when times were tough, laughed with me when times were funny (and sometimes not so funny), taught me when I needed to learn, listened when I needed to talk, picked me up when I was down, motivated me when I wanted to give up, and stomped me down and made me cry when I needed to be put in my place. I can only hope that I can be half the supervisor to my supervisees that you were to me. Keep changing lives because that is what you were born to do.

ACKNOWLEDGEMENTS

I would first like to thank my mom, Rhonda, other mama, Adina, all my siblings, and my children for their continuous support of my work and pursuit of my dreams. My oldest, Lexalynn, has never known what it is like to have a mom who isn't in college for her 9 years of life. Lexalynn, you attended college classes with me, put up with college activities I participated in, gave me foot and back massages when I was up working late on homework, missed playdates and birthday parties so I could complete assignments, played with and occupied your younger siblings so that I could work in peace, and sacrificed numerous other things so that I could pursue my dreams. I cannot wait until the day when I can repay the favor and help you pursue your dreams. I know you dream big and will accomplish anything you put your mind to. To my younger siblings and children, I pray you will look at my sacrifice to get to where I am today and be inspired to pursue whatever your dreams may be no matter what obstacles you may encounter along the way.

I also want to thank my Uncle Rodney for babysitting for me when I had evening classes so that I could continue my education, despite my not always having money to pay him. I want to thank all of my family for their unending support and assistance as I have gone through college for the last 10 years to get where I am today.

I would also like to thank my advisor, Terry Falcomata, for picking me up and helping me through the last half of my program when I was left without an advisor without notice. Terry has guided me and assisted me in so many ways over the last two years to make sure I was able to continue the path I had set for myself and graduate on time. Terry helped me to develop my research writing skills so that I could complete this dissertation. Thanks to everybody on my dissertation committee for helping me on this journey. Special thanks to Dr. Cooc who was willing to step in last minute as a committee member so I didn't have any delays. I appreciate it!

Lastly, I would like to thank Claudia Zamora for supporting me personally, educationally, and professionally over the past 4 years. Thank you for covering clients when I had school to tend to, answering my endless questions when I had no idea what I was doing, watching hours of videos to collect IOA data, helping co-parent my kids when I needed assistance, babysitting (and offering to babysit) when I was in a bind, and for always being there when I needed you. Without your help and support I would not be here today. For that I am forever grateful! I look forward to a lifetime of business ownership with you my dearest work-wife!

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by

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The University of Texas at Austin, 2019

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Abstract

Stereotypy has been defined as repetitive vocal or motor behaviors that occur throughout the day with no apparent function to the related activity (Martinez, Betz, Liddon, & Werle, 2016). It has been identified as one of two major destructive behaviors, second to self-injurious behavior, due to its impact across areas of functioning, such as education and social (National Institute of Health, 1989). Research has suggested that response interruption and redirection (RIRD) is an effective intervention to decrease stereotypy in children diagnosed with ASD. Although the basic RIRD arrangement has been demonstrated to be effective in numerous studies, the results of some previous studies have suggested that the intervention may be effective with adaptions that might ultimately increase the generality of the intervention (e.g., signaled RIRD; intermittent application of RIRD). Thus, the purpose of the current study is to evaluate the relative effects of the standard RIRD procedure, RIRD implemented on a variable ratio schedule, and signaled RIRD (i.e., discrimination training with RIRD) on stereotypy exhibited by children diagnosed with Autism Spectrum Disorder who engage in automatically maintained stereotypy.

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Chapter 1: Introduction

Restricted and repetitive behavior, otherwise known as stereotypy, is one of three core deficits in children diagnosed with an autism spectrum disorder (ASD; American Psychiatric Association, 2013). Stereotypy is described as repetitive motor or vocal behaviors that have no apparent social environment-based function. Stereotypy can include behaviors such as hand-flapping, toe-walking, using odd patterns or pitches in language, scripting previously heard language, body rocking, spinning objects, immediate and delayed echolalia, demonstrating uncommon interests, or requiring routine or structure in all activities (American Psychiatric Association, 2013; Schreibman, Heyser, & Stahmer, 1999). When a behavior is repetitive, rigid, and has invariance, it may be considered stereotypy (Turner, 1999). Stereotypic behaviors may be considered as part of a core deficit in children with ASD. In regards to stereotypy, individuals with ASD tend to demonstrate a variety of topographies, increased severity, increased occurrence of stereotypy, and lack developmental and social appropriateness (Bodfish, Symons, Parker & Lewis, 2000; Piaza et. al., 2000).

The earliest mention of stereotypy in the literature stated that instincts are stereotyped, unlearned acts (Zorbaugh, 1928). In 1944, Levy described stereotyped movements as primitive behavior that occurs because one's movements and/or thoughts are restricted to a small area. Levy related stereotypy to the postural and motor movements common with catatonia. According to Levy, the origin of stereotyped movements is unknown. Three additional articles in the early literature of stereotypy discussed stereotypic behavior in individuals with schizophrenia (i.e., Bak, 1939; Fromm-Beichmann, 1943; Myers, 1947). Fromm-Beichmann (1943) described the reason for stereotyped behaviors in individuals with schizophrenia in terms of the individuals

wanting to remain “cryptic and ambiguous” for defensive reasons; and that stereotypy “covers up feelings.” Meyers (1947) agreed with Fromm-Beichmann (1943) and added additional reasoning for stereotyped behavior to be an attempt to tell a story, as part of the psychological mechanisms of identification and introjection, or as an attempt at self-healing and self-analysis. Early literature on stereotypy had one theme in common: stereotypic behaviors have a relation to psychological mechanisms and the full source that produces the behaviors has yet to be explained.

Stereotypy can impair the individual’s ability to function independently, participate in everyday activities, decreases the availability of learning opportunities, can be socially stigmatizing, and can directly interfere with learning (Cunningham & Schreibman, 2008; Piazza et. al., 2000; Storey, Bates, McGhee, & Dycus, 1984). Due to the adverse impact that stereotypy can have on individuals’ functioning, it can, at times, be vital that it be addressed before implementing other interventions to improve functioning in other areas (Harris & Wolchik, 1979); such as academic, social, vocational, and life skills. However, automatically reinforced behavior can be difficult to address due to the unknown nature of the reinforcer, the inability of the therapist to manipulate the reinforcer, and because the behavior and reinforcer are inseparable (Piazza et. al., 2000). Due to the difficulty in addressing stereotypy it is important to develop behavior interventions according to the function of the stereotypy rather than the topographical class (Cunningham & Schreibman, 2008).

Studies (e.g., Cunningham & Schreibman, 2008; Koegel, Firestone, Kramme, & Dunlap, 1974) have provided evidence that stereotypy can interfere significantly with learning and appropriate play skills. Research has also shown that when stereotypy is successfully reduced it

can be directly related to increased correct responding in class, successful discrimination, and spontaneous play behavior (Cunningham & Schreibman, 2008; Koegel, et al., 1974).

More recently, extensive research has provided evidence that stereotypy is maintained by automatic reinforcement (e.g., Lovaas et al., 1987; Piazza, Adelinis, Hanley, Goh, & Delia, 2000; & Rapp, 2006). Automatic reinforcement is considered to be present, or a maintaining factor for behavior, when the individual receives reinforcement other than from social sources (Vaughan & Michael, 1982). In other words, the behavior is maintained by internal reinforcement instead of from external sources. A growing body of literature has also shown that stereotypy can have multiple functions, including social positive and negative reinforcement (e.g., Ahearn, Clark, Gardener, Chung, & Dube, 2003; Durand & Carr, 1987; Kennedy, Meyer, Knowles, & Shukla, 2000; Tang, Patterson, & Kennedy, 2003).

While research investigating methods aimed at reducing stereotypy and the maintenance of the reduction in the natural environment has had limited success, there are a few interventions that have been demonstrated to reduce stereotypy. These interventions include functional matching procedures (e.g., Love, Miguel, Fernand, & Labrie, 2012; Piazza et al., 2000; Rapp, 2006), punishment procedures such as overcorrection (e.g., Fox & Azrin, 1973; Lovaas, Schaeffer, & Simmons, 1965), utilizing the stereotypic behavior as reinforcement contingent upon target behaviors (e.g., Hanley, Iwata, Thompson, & Lindberg, 2000), differential reinforcement (e.g., Dickman, Bright, Montgomery, Miguel, 2012; Kennedy et al., 2000), and response interruption and redirection (RIRD; e.g., Ahearn et al., 2007; Ahrens, Lerman, Kodak, Worsdell, & Keegan, 2011; Carroll & Kodak, 2014; Cassella, Sidener, Sidener, & Progar, 2011; Love, Miguel, Fernand, & Labrie, 2012; Lui-Gitz & Banda, 2010; Martinez, Betz, Liddon,

Werle, 2016; Pastrana, Rapp, & Frewing, 2013; Saini, Gregory, Uran, & Fantetti, 2015; Schumacher & Rapp, 2011; Shawler & Miguel, 2015; Sloman, Schulman, Torres-Viso, & Edelstein, 2017).

Sensory extinction is a way to decrease levels of stereotypy by response blocking (i.e. interrupting the stereotypy) or modifying the environment such that the child cannot access the purported sensory stimulation the stereotypy provides. Functional matching procedures have been shown to decrease stereotypy by providing access to stimulation that matches the purported stimulation given by the stereotypy contingent upon occurrence of stereotypy (e.g., Gibbs, Tullis, Thomas, and Elkins, 2018; Spector, 2018). However, providing response-independent access to matched stimulation is not always effective (e.g., Taylor, Hoch, Weissman, 2005). Differential reinforcement alone has also been shown to be less effective at decreasing stereotypy relative to when response blocking is included as part of a treatment package (e.g., Fellner, Laroche, & Sulzer-Azaroff, 1984).

RIRD utilizes sensory extinction by response blocking each instance of stereotypy. RIRD has also been conceptualized as a procedure that utilizes punishment (Ahearn et al., 2007; Ahrens et al., 2011; Cassella et al., 2011; i.e., the requirement that the individual complete a series of actions/tasks prior to the redirection back to the original activity may be considered positive punishment). To date, RIRD has been associated with promising results for decreasing stereotypy. However, questions remain regarding the most effective RIRD arrangement(s), generalization to natural settings, the extent to which care providers may be able to implement the procedures with integrity, and/or long-term decreases in stereotypy.

Interruption (i.e. response blocking) is considered a vital component of RIRD. Prior to the coining of the term RIRD (Ahearn et al., 2007), several studies utilized interruption as an intervention for stereotypy. For example, Azrin and Wesolowski (1980) first utilized the concepts of differential reinforcement plus interruption to decrease stereotypy. Azrin and Wesolowski showed that the addition of interrupting the steroetypy to the differential reinforcement procedure was effective at decreasing motor stereotypy with the one participant in the study. Fellner, Laroche, and Sulzer-Azaroff (1984) further examined differential reinforcement and interruption and found that even with relatively short interruptions, a consistent reduction in stereotypy was observed. Subsequent studies also found that interruption was successful at decreasing stereotypy (e.g., Aurand, Sisson, Aach, & Hasselt, 1989; Myrbakk, 1991; Tarbox, Wallace, and Tarbox, 2002); with one study (i.e., Tarbox et. al, 2002) finding that interruption failed to be effective when fixed interval (FI) schedule thinning was implemented up to FI 90 s.

DISCRIMINATION TRAINING/SIGNALED RIRD

Discrimination training is utilized to bring a behavior under the control of a stimulus by utilizing differential reinforcement and extinction, but might also occur vai a process of inhibitory control. Davis, Bruce, Snyder, and Nelson (2003) define inhibitory control as "the capacity for active inhibition or modulation of a response." The establishment of inhibitory stimulus control involves the presentation, or inclusion, of a previously neutral stimulus (e.g., a red card or other signal) along with an aversive consequence (i.e., a punishing stimulus) that is presented contingent upon a target behavior (e.g., stereotypy). Therefore, the neutral stimulus is paired with the aversive consequence (Sulzer-Azaroff & Mayer, 1991). When inhibitory control

is established, reductions in target responding are observed in the presence of the previously neutral stimulus as a result of its pairing with the aversive consequence. If one can establish inhibitory control over stereotypy, then it becomes more feasible to address the behavior, especially in the natural environment (e.g., Rapp, Patel, Ghezzi, O'Flaherrty, & Titterington, 2009; Martinez et al., 2016). Previous studies (e.g., Brusa and Richman, 2008) have demonstrated that stimulus control interventions may be effective for children who engage in stereotypy. Specifically, Brusa and Richman (2008) utilized red cards to signal that stereotypy would result in an aversive consequence while green cards signaled to the child that stereotypy would not result in programmed consequences. The child's teacher implemented the intervention, providing preliminary evidence that inhibitory stimulus control-based interventions may increase the generality of the intervention to the natural environment.

The consequence-based components of RIRD (i.e., blocking the stereotypy and requiring a series of responses) have been conceptualized as punishment-based procedures. Punishment is "a consequence of behavior that reduces the future probability of that behavior" (Azrin & Holz, 1966). Given the conceptualization of RIRD in terms of the presence of punishment as a behavioral mechanism, it may be worthwhile to consider inhibitory stimulus control as a potential adaption of the treatment. RIRD paired with discrimination training has been referred to as "Signaled RIRD" (Ahrens, Lerman, Kodak, Worsdell, & Keegan, 2011). All research to date that has utilized Signaled RIRD has utilized a green card to signal to the individual that stereotypy would not be consequated and a red card to signal the presence of a contingent aversive consequence. Ahrens et al. (2011) was the first study to attempt to utilize discrimination training with RIRD. Specifically, in Ahrens et al., each session was paired with a different

therapist (and different consequence) for three out of four participants. The results were the same across participants in that discrimination training did not appear to alter the effects of the intervention. Another study (i.e., Love, Miguel, Fernand, & LaBrie, 2013) investigated discrimination training by having one therapist wear a blue shirt during matched stimulation RIRD sessions and a black shirt during sessions in which matched stimulation was not available while only RIRD occurred. The results of Love et al. (2013) indicated that RIRD was successful at decreasing stereotypy, but because discrimination training was not isolated as an independent variable within the study, the extent to which they were able to draw conclusions about the effects of discrimination or whether inhibitory stimulus control was established was limited. Schumacher and Rapp (2011) also utilized discrimination training by placing a red paper on the wall during the RIRD session. They found that stereotypy decreased during the RIRD condition; when RIRD was terminated, stereotypy did not immediately increase. However, discrimination training was not evaluated as part of the independent variable in the study. Thus, the effects of discrimination on stereotypy was not isolated and evaluated. For each of these three studies, it is unknown as to whether the therapists, shirts, or red paper utilized for discrimination functioned as discriminative stimuli.

Martinez et al. (2016) published the first study to utilize discrimination training as an independent variable and evaluate directly the effects of pairing discrimination training and RIRD. Martinez et al. included two experiments. During Experiment 1 the experimenters utilized a pink poster that was later faded to a pink card on a table to indicate that RIRD was in effect. They were unable to achieve inhibitory control over the stereotypy for the one participant in the experiment. During Experiment 2 they utilized the same pink card, but evaluated the difference

between using mastered listener vs. mastered speaker tasks during RIRD; and they introduced the procedure to natural teaching sessions and extended the duration of time RIRD was implemented. Because the second experiment did not evaluate discrimination training as an independent variable, the results did not show whether the pink card was a discriminative stimulus and might have contributed to the decrease in stereotypy.

Sloman et al. (2017) published the most recent study that addressed discrimination training and RIRD to address stereotypy in the school and community settings. Signaled RIRD was utilized during two activities throughout the day (morning group and independent activities) by having a red card signal when stereotypy was not allowed. While the red card was present, RIRD was implemented contingent on each instance of stereotypy. During two additional activities throughout the day (i.e., desk-work and community) the red card was present, but RIRD was not implemented contingent upon stereotypy. Signaled RIRD effectively decreased vocal stereotypy across both morning-group and independent activities. During desk-work when RIRD was not implemented while the red card was present, the authors initially observed a decrease in stereotypy, followed by an increase to near-baseline levels. There was no effect on the stereotypy within community settings when RIRD was not implemented while the red card was present.

Most research on discrimination training has been conducted during preferred activities with no demands present (e.g., Ahearn et al., 2007, Ahrens et al., 2011; Athens et al., 2008, Cassella et al., 2011; Martinez & Betz, 2016). Sloman et al. (2017) was the first study to evaluate signaled RIRD during demands and activities the child would typically encounter throughout their day. They were also the first to have a control session that tested the effectiveness of the

stimulus cue in the absence of RIRD as a consequence for stereotypy. Results showed discrimination training (i.e. signaled RIRD) was effective at decreasing stereotypy.

VARIABLE RATIO OF PUNISHMENT

Intermittent schedules of punishment have been shown to produce greater resistance to extinction (i.e. cannot be easily extinguished) and enhanced suppression relative to fixed response-based schedules of punishment (Deur & Parke, 1970; Estes, 1944; Jones, 1953). Intermittent punishment schedules have also shown some positive, albeit inconsistent effects in previous applied research (e.g., Lerman, Iwata, Shore, & DeLeon, 1997; Tarbox et. al., 2002). Variable ratio (VR) schedules of punishment are implemented based on a specific ratio (e.g. every 3rd time the behavior occurs). To my knowledge, all studies on RIRD that have utilized intermittent schedules have utilized interval-based schedules.

Previous research studies on RIRD have implemented RIRD using intermittent schedules (Martinez et al., 2016; Sloman et al., 2017); however, these studies utilized fixed interval (FI) schedules rather than a ratio-based schedules. Implementing RIRD on an interval schedule has shown to be inconsistently effective (e.g., Martinez et al., 2016; Sloman et al., 2017). Further, Ahrens et al. (2011) implemented RIRD on FR 2, FR 4, and FR 10 schedules. They found that stereotypy remained low during the FR 2 schedule, temporarily increased and then decreased again during the FR 4, and increased to baseline during the FR10 schedule. Regardless of the limited research, there have been only a handful of applied studies that have shown variable punishment to be successful at decreasing behavior when it is implemented immediately following a brief time period (e.g. 1 minute) of continuous punishment (e.g., Rollings &

Baumeister, 1981; Romancyzk, 1977). The effects of using VR-based RIRD have yet to be researched.

Purpose of the Current Study

The purpose of the current study is to compare the effects of RIRD, RIRD that is implemented on a VR schedule, and signaled RIRD on vocal and motor stereotypy. Previous research has shown (a) the standard RIRD preparation is often effective at reducing stereotypy, (b) signaled RIRD may also be effective at reducing stereotypy, and (c) RIRD implemented on interval-based schedules has produced inconsistent results. Other previous studies pertaining to the general topic of punishment has shown that VR-based schedules of punishment suppress' responding relative to other punishment-based arrangements. However, no previous studies have compared these different variations of RIRD within the context of a single evaluation. Further, there is also no research to date on the effects of RIRD on a variable ratio schedule. Thus, the purpose of this study is to evaluate whether one variation of RIRD will result in greater reductions in stereotypy relative to the other variations.

Chapter 2: Empirical Review of RIRD Literature

The National Institutes of Health (1989) categorizes self-stimulatory behaviors as one of two (i.e., *self-injurious behaviors)* major destructive behaviors that can have a serious impact on all areas of life, such as social and educational functioning. These stimulatory behaviors impair the individual's ability to function independently and participate in everyday activities (Storey, Bates, McGhee, & Dycus, 1984). Stereotypy can be repetitive motor actions (e.g. hand flapping) or repetitive verbalizations (e.g. humming). Due to the adverse impact that both types of stereotypy have on individuals' functioning, it is vital that they be addressed before implementing other interventions to improve functioning in other areas (Harris & Wolchik, 1979); such as academic, social, vocational, and life skills. Unfortunately, there are few effective treatments for stereotypy.

Response interruption and redirection (RIRD) is a treatment for stereotypy that is based on applied behavior analytic principles, such as discrimination training, reinforcement, punishment, differential reinforcement, and response blocking. Ahearn, Clark, MacDonald, and Chung (2007) conducted the first evaluation of the effects of response interruption and redirection (RIRD) on vocal stereotypy. Specifically, Ahearn et al. first conducted functional analyses (Iwata, Dorsey, Slifer, Bauman, & Richman, 1994) on vocal stereotypy exhibited by four individuals with ASD diagnoses. The results of the functional analysis (FA) demonstrated automatic functions for all four participants. Next, the authors evaluated RIRD within an ABAB withdrawal design. During RIRD, the authors (a) provided praise contingent on participants' use of appropriate communication, (b) reinforced requests, (c) interrupted all occurrences of vocal

stereotypy, and (d) redirected to alternative vocalizations. Redirection consisted of the authors presenting vocal prompts to the participants (e.g., "What's your name?"; Ahearn et al., 2007, p. 269); with vocal imitation prompts used with one participant. Following compliance with three consecutive prompts, the authors ceased providing the vocal prompts and provided praise. The results of the study suggested that RIRD was effective at decreasing vocal stereotypy in all four children relative to baseline conditions. Appropriate communication also increased during RIRD relative to baseline with two of the four participants. The results of Ahearn et al. provided the initial demonstration of the positive effects of RIRD on vocal stereotypy. Subsequent studies (e.g., Ahrens, Lerman, Kodak, Worsdell, & Keegan, 2011; Carroll & Kodak, 2014; Cassella, Sidener, Sidener, & Progar, 2011; Dickman, Bright, Montgomery, Miguel, 2012; Lui-Gitz & Banda, 2010; Love, Miguel, Fernand, & Labrie, 2012; Martinez, Betz, Liddon, Werle, 2016; Pastrana, Rapp, & Frewing, 2013; Saini, Gregory, Uran, & Fantetti, 2015; Schumacher & Rapp, 2011; Shawler & Miguel, 2015; Sloman, Schulman, Torres-Viso, & Edelstein, 2017) have provided further support for the utility of RIRD on vocal stereotypy.

Ahrens et al. (2011) extended the literature pertaining to RIRD by evaluating the treatment's effects on motor stereotypy in a three-experiment study. Ahrens et al. first conducted functional analyses (Iwata et. al., 1994) on vocal and motor stereotypy exhibited by four individuals with ASD diagnoses. The results of the functional analyses demonstrated automatic functions for all four participants. For the first experiment, the authors combined a reversal and multielement design to compare the effects of two RIRD techniques on vocal stereotypy. During RIRD, contingent on vocal stereotypy the authors (a) neutrally stated child's name, (b) asked social questions that required vocal responses (e.g., "What is your name?") or instructions that

required vocal responses (e.g., “say ‘Mom’”), (c) prompted an answer after 5 seconds of non-response, and (d) reinforced responses. Following three consecutive RIRD trials, without engaging in stereotypy, the authors ceased providing vocal demands and provided praise. Unlike Ahearn et al. (2007) the child did not have to comply with all vocal demands to terminate RIRD. During RIRD, contingent on motor stereotypy the authors (a) delivered motor response instruction, (b) provided physical prompting if no response within 5 seconds, and (c) reinforced responding. Following three consecutive responses, with or without prompting, without engaging in stereotypy, the authors ceased providing motor response instructions and provided praise. During RIRD, contingent on both motor and vocal stereotypy, the authors responded to any appropriate vocalization (e.g., “I see the camera”, “I want the book”, “look at me”) by providing attention or item requested. The authors continued sessions for 5 minutes, not including time in RIRD procedure, or until 30 minutes had passed. The results of Ahrens et al. experiment one suggested that both vocal and motor RIRD were effective for reducing vocal stereotypy. Most notably, this study provided the initial demonstration that (a) vocal redirection is not necessary to increase appropriate vocalizations (b) compliance with requests is not required for RIRD to have positive effects on vocal and motor stereotypy, (c) the form of the instructed response does not have to match the form of the stereotypy, and (d) vocal RIRD functioned as punishment for the participants.

In their second experiment, Ahrens et al. (2011) used a combined reversal and multielement design to compare the effects of vocal and motor RIRD on vocal and motor stereotypy. During RIRD, the authors (a) delivered vocal questions or instructions that required a vocal response (e.g., “How old are you?” “A dog says ____”) during vocal RIRD, (b) delivered

small motor movement instructions (e.g., clap hands, pat lap, arms up) during motor RIRD, and (c) provided prompts after 2-3 seconds of nonresponse. Sessions continued for 10 minutes, not including time in RIRD procedure, or until 30 minutes elapsed. The results of Ahrens et al. experiment two suggested that (a) both variations of RIRD were effective at reducing vocal and motor stereotypy, (b) motor RIRD was slightly more effective than vocal RIRD at reducing both forms of stereotypy, (c) matching the form of RIRD to topography of stereotypy does not have any advantages, and (d) that vocal and motor RIRD function as punishment for the participants in the study.

In their third experiment, Ahrens et al. (2011) examined the process responsible for vocal RIRD effects on responding. Ahrens et al. (2011) utilized procedures to differentiate between extinction and punishment, similar procedures to Lerman and Iwata (1996). The rationale for differentiating between extinction and punishment is that stereotypy would decrease as RIRD was implemented for more occurrences of stereotypy if it functioned as punishment. Stereotypy would persist and possibly increase as RIRD was implemented for more occurrences of stereotypy if it functioned as extinction. Based on this rationale, the authors implemented three fading steps: 1) no implementing RIRD for stereotypy, 2) implement RIRD for 50% of stereotypic responses, and 3) implement RIRD for 25% of stereotypic responses. The same vocal RIRD protocol from experiment one was implemented. The results of experiment three suggested that RIRD is punishment because stereotypy decreased with the richer schedules of RIRD.

Previous studies have also evaluated RIRD in combination with other treatment components. Various multi-component treatment packages have included RIRD plus a no

interaction (NI) component (Carroll & Kodak, 2014; Pastrana et al., 2013; Schumacher & Rapp, 2011); RIRD plus a non-contingent reinforcement (NCR) component (Carroll & Kodak, 2014); RIRD plus a differential reinforcement of incompatible behaviors (DRI) component (Dickman et al., 2012); and signaled RIRD (Sloman et al., 2017).

Two studies utilized a NI component within a multielement design (Pastrana et al., 2013; Schumacher & Rapp, 2011). Pastrana et al. and Schumacher and Rapp both alternated RIRD and NI within three components. Each component was implemented for three consecutive 10-minute components.

Carroll and Kodak's first study (2014) compared RIRD plus no interaction (NI) components within an alternating treatment designs to compare the effects of RIRD to NI during interrupted and uninterrupted measures of vocal stereotypy. When utilizing uninterrupted measures of stereotypy, the total duration of engagement in stereotypy, both in and outside RIRD, are calculated. When utilizing interrupted measures of vocal stereotypy only the duration of engagement in stereotypy outside of RIRD is calculated. During the NI treatment the authors were present in the room but did not interact or respond to the participant during the entire session. The NI component was conducted to demonstrate the persistence of vocal stereotypy in the absence of social consequences (Carroll & Kodak, 2014). During RIRD, the authors (a) presented motor demands contingent on vocal stereotypy, (b) repeated demand and modeled after 5 seconds of nonresponse, (c) repeated demand and physically prompted compliance after 5 additional seconds of nonresponse, (d) continued motor demands until three demands were completed, prompted or unprompted, without engagement in stereotypy. The results of study one identified that vocal stereotypy (a) appeared to decrease to near-zero levels when interrupted

measures of vocal stereotypy were calculated and (b) appeared to only have minimal reductions when uninterrupted measures of vocal stereotypy were calculated. This finding suggests that uninterrupted measures of vocal stereotypy may be the best way to collect data for RIRD so as not to overestimate the results.

Carroll and Kodak's second study (2014) evaluated RIRD plus non-contingent reinforcement (NCR) within an alternating treatments design to compare the effects of stereotypy during RIRD, NCR, and NI. The authors first conducted free operant preference assessments to identify participants top preferred items. The top three preferred items were utilized as NCR items to compete with stereotypy. During the NCR component, the participant received continuous and noncontingent access (i.e., access to the preferred items regardless of behavior) to the top three items from their preference assessments. The authors were in the room but did not interact with the individuals during the NCR component. The RIRD and NI components were implemented the same as study one. The results of this study were similar to study one in that: (a) calculating interrupted duration data further decreases the duration of stereotypy, thus creating a larger perceived effectiveness for RIRD and (b) vocal stereotypy decreased during NCR across both interrupted and uninterrupted measures of stereotypy.

Dickman et al. (2012) conducted a study on RIRD plus differential reinforcement of incompatible behaviors (DRI) within a reversal design. During RIRD sessions, RIRD was implemented (a) interrupting vocal stereotypy during each occurrence, (b) placing a series of demands to engage in vocal responses, and (c) continuing until three consecutive questions are answered in the absence of vocal stereotypy. During RIRD + DRI, the above RIRD protocol is implemented while the participant is simultaneously reinforced with tokens when they engage in

appropriate vocalizations. Each token could be exchanged for a small edible at the end of the session. The results of this study suggested, as in previous studies, that RIRD leads to increases in appropriate vocalizations. This study also suggests that the addition of an outside reinforcer, such as a token, can lead to further increases in appropriate vocalizations and decreases in vocal stereotypy.

Sloman et al. (2017) evaluated the effect of signaled RIRD on stereotypy within a concurrent multiple-baseline design. This study evaluated the relationship between RIRD and three different conditions: signaled RIRD, stimulus cue only (SCO), and intermittent RIRD. During signaled RIRD, the authors (a) presented the stimulus cue (red card), (b) told the participant "when the red card is out, you have to have a quiet mouth", (c) implemented the RIRD protocol after each occurrence of vocal stereotypy by asking a series of questions that required vocal responses, and (d) continued RIRD until three correct answers were given without engagement in vocal stereotypy. During SCO, the authors evaluated potential carryover effects of the cue by presenting the red card and verbal instructions, but not implementing RIRD for engagement in vocal stereotypy. During intermittent RIRD, the signaled RIRD condition was repeated, but the implementation of RIRD was done on an intermittent schedule instead of a fixed schedule. In other words, RIRD was implemented as a consequence for vocal stereotypy for the first minute of each session and then on a fixed interval of 1 minute thereafter. The results of this study suggest that (a) consistent implementation of signaled RIRD decreases RIRD implementation, (b) an intermittent schedule of RIRD implementation decreases vocal stereotypy, (c) time spent in RIRD decreases over time, and (d) intermittent RIRD helps decrease the time spent implementing RIRD in the natural environment.

A previous review of the literature pertaining to RIRD (i.e., Martinez and Betz, 2013) examined eight studies in which RIRD was implemented as an intervention for stereotypy. This is the only synthesis completed on the use of RIRD to address stereotypy. Martinez and Betz's review, which reviews studies published between 2007 and 2012, showed that all studies prior to that synthesis focused on vocal stereotypy, with the exception of 1 participant who also engaged in motor stereotypy. The results of this study suggested that all procedural variations of RIRD were successful at reducing stereotypy; however, despite the overall success at reducing stereotypy, Martinez and Betz noted that gaps in the research remain. Discrimination training may enhance generalization, but no studies to date have assessed stimulus control by presenting the discriminative stimuli in the absence of consequences or in novel conditions. All of the studies reviewed lasted 5-10 minutes and the impact of RIRD being implemented for longer durations has not yet been evaluated. Treatment integrity and social validity measures were only reported in two studies (Casella et al., 2011; Love et al., 2012); thus future studies should report these measures because the effectiveness of RIRD may be effected based on treatment integrity and social validity. Martinez and Betz also noted that researchers should examine RIRD implementation with integrity levels similar to what may occur in the natural environment.

Subsequent to the publication of Martinez and Betz (2013), eight additional studies evaluating RIRD as well as aspects related to the treatment have been published (Carroll & Kodak, 2014; Dickman et al., 2012; Lui-Gitz & Banda, 2010; Martinez et al., 2016; Pastrana et al., 2013; Saini et al., 2015; Shawler & Miguel, 2015; Sloman et al., 2017). These have included two additional studies evaluating the effects of RIRD as an intervention for motor stereotypy (Pastrana et al., 2013; Saini et al., 2015) and 11 additional studies that focused on vocal

stereotypy (Carroll & Kodak, 2014 study 1 & 2; Dickman et al., 2012; Liu-Gitz & Banda, 2010; Martinez et al., 2016 study 1, 2, & 3; Pastrana et al., 2013; Saini et al., 2015; Shawler & Miguel, 2015; and Sloman et al., 2017). The purpose of the current study was to review the research pertaining to RIRD published subsequent to Martinez and Betz (Carroll & Kodak, 2014; Martinez et al., 2016; Pastrana et al., 2013; Saini et al., 2015; Shawler & Miguel, 2015; Sloman et al., 2017), or studies not previously reviewed by Martinez & Betz (Dickman, Bright, Montgomery, Miguel, 2012 and Lui-Gitz & Banda, 2010).

METHOD

This review involved a systematic review of research studies done using RIRD to address stereotypy in young children diagnosed with an ASD. All studies utilizing RIRD to address stereotypy that were not included in the last synthesis of RIRD by Martinez and Betz were included in the present synthesis. All studies that met inclusion criteria were analyzed and summarized based on the a) participants, b) type of stereotypy, c) type of intervention, d) IOA, e) procedural integrity, f) duration of the intervention, g) intervention design, and h) the results of the intervention.

Independent and Dependent Variables

The independent variable in this synthesis is the response interruption and redirection (RIRD) intervention, which includes RIRD alone, RIRD + NI, RIRD + NCR, RIRD + DRI, and Signaled RIRD. The dependent variable is stereotypy. Stereotypy may be either motor or vocal. This was measured in every study by the percentage of intervals with stereotypy present.

Search Procedures

A systematic search of the literature was conducted. Five databases, Academic Search Complete, Education Source, PsychINFO, ERIC, and Psychology and Behavioral Sciences Collection, were utilized to find studies published on interventions addressing self-stimulatory behaviors in children with ASD. Line 1 of the search field contained ““autis*” OR “ASD” to retrieve all studies related to autism or autism spectrum disorder. Line 2 of the search field included “intervention*”. The third line contained ““self stimulat*” OR “stimulat*” OR “stereotyp*””, to reflect the field’s use of a variety of terms for these behaviors, such as “self-stimulatory behavior, self-stimulation, stimulatory behaviors, self-stim, and stereotypy. The search was restricted to peer-reviewed articles in academic journals that were published in English. This search produced 1,169 articles. A time from of 2007-2017 was put in place to further narrow down the literature. The date of 2007 was used because that is the first year that a study on RIRD was published. The year 2017 was used because that is the year this synthesis was written. This narrowed the number of articles from 1,169 to 892. From this list of 892, the titles and abstracts were read to see if they included RIRD and sorted articles into one of three categories: yes, maybe, and no, narrowing it to a total of 82 articles left in the yes and maybe categories combined. Papers in the yes and maybe categories were closely read and analyzed to identify the inclusion or exclusion criteria. As the articles were read they were narrowed by hand to ensure they utilized RIRD to address stereotypy and that they were not included in the previous synthesis on RIRD by Martinez & Betz (2013).

Inclusion and Exclusion Criteria

To be selected for the synthesis, studies had to meet the following criteria. First, the participants had to have a diagnosis of ASD and be 18 years old or younger. Second, the intervention had to be put in place to primarily address stereotypy utilizing RIRD. Third, the article had to be written in English. Fourth, studies had to be quantitative. Fifth, studies had to be peer-reviewed in an academic journal. Lastly, to be included they had to be published between 2007 and 2017. Studies were excluded if they were case studies, if the intervention was targeting self-injurious behaviors, or if the studies were included in the previous synthesis by Martinez & Betz (2013).

Coding Procedures

Extensive coding procedures were used to organize information from each of the studies. The code sheet was adapted from a coding sheet created by The Meadows Center for Preventing Educational Risk. The coding sheet was altered to match the current research question regarding vocal stereotypy using RIRD. These coding sheets were used to record information about general study characteristics, participant information, self-stimulatory behavior information, fidelity of the intervention procedures, duration of the intervention, and the general findings as to whether the intervention was effective. Participant information was coded using forced choice and open-ended items (i.e. cognitive level of participants, gender, age, place of intervention). Vocal stereotypy was coded using open ended items (i.e. type of stereotypy behaviors and operational definitions). Intervention information was coded using open ended items (i.e. implementer, IOA, procedural integrity, intervention design, duration of intervention, effectiveness).

Interobserver Agreement

The researcher developed a coding guide to extract data on participant and study characteristics. The researcher trained an independent coder on coding the data by coding articles with the researcher using the coding guide. Reliability was established using the coding sheets by training until the primary researching and independent observer reached 100% agreement. After establishing reliability, the independent coder coded two studies included in this synthesis. The primary researcher coded the remaining studies independently. The researcher and independent coder achieved 100% agreement in coding on the two coded studies.

RESULTS

Eight articles, with a combined total of 11 studies, met inclusion criteria for the synthesis. All studies were single case designs. Effect size was measured using percentage of non-overlapping data (PND) for all studies. Table 1 provides an overview of each of the studies based on (a) participants, (b) type of stereotypy, (c) type of intervention, (d) interobserver agreement (IOA), (e) procedural integrity, f) duration of the intervention, g) intervention design, and h) effectiveness of the intervention. Tables 2 provides the PND as compared to the previous phase for studies that used reversal designs. Table 3 provides the overall mean PND for studies that used the alternating treatments design. Table 4 provides the overall mean PND for the one study that utilized the multiple baseline treatment design.

PND calculation

All of the articles in this synthesis are single case design. PND as compared to the previous phase was calculated for each study. Since our studies were attempting to decrease stereotypy in the children, when comparing PND to a previous baseline phase PND was

calculated by identifying the lowest data point in the previous baseline phase and counting the total number of data points that fell below this point in the phase. When comparing baseline to a previous intervention phase, PND was calculated by identifying the highest data point in the previous intervention phase and counting the total number of baseline data points that were above that point. The number of non-overlapping data points, whether higher or lower, was then divided by the total number of intervention points (Olive & Smith, 2005). According to Scruggs and Mastropieri (1998) a PND calculation of 90% or above is considered highly effective, 70-90% are moderately effective, 50-70% are minimally effective, and less than 50% is ineffective.

Participants

Collectively, the 11 studies included 21 participants. Each study included a sample size of one to five participants. There were 20 males (95%) and 1 female (5%). All participants were diagnosed with autism with the exception of one 5-year-old male who was diagnosed with Pervasive Developmental Disorder Not Otherwise Specified (PDD-NOS). Participants ranged from 5-12 years old.

Independent and Dependent Variables

The independent variable in each study was the implementation of procedural variations of RIRD. Three studies implemented RIRD only (Liu-Gitz & Banda, 2010; Saini et al., 2015; Shawler & Miguel, 2015), two studies implemented RIRD and no interaction interventions (Carroll & Kodak, 2014; Pastrana et al., 2013), one study implemented RIRD, no interaction, and NCR interventions (Carroll & Kodak, 2014), one study implemented RIRD and RIRD plus differential reinforcement of incompatible behaviors (RIRD + DRI) (Dickman, Bright,

Montgomery, & Miguel, 2012) and four studies implemented signaled RIRD (Martinez, Betz, Liddon, & Werle, 2016; Sloman, Schulman, Torres-Viso, & Edelstein 2017). The dependent variables were vocal stereotypy, motor stereotypy, or both.

Duration

Two studies continued all sessions utilizing RIRD each time stereotypy occurred until five minutes has elapsed without implementing RIRD (Saini et al., 2015; Shawler & Miguel, 2015). Two studies continued sessions until RIRD was not implemented for 5 minutes or until the session had reached a total of 10 to 30 minutes, depending on the client (Carroll & Kodak, 2014). One study had identical 10-minute sessions for each component (Pastrana et al., 2013). One study varied each session, but never exceeded 12 minutes (Dickman et al., 2012). One varied from 5-30 minutes in length (Martinez et. al., 2016) and another varied from 280-837 seconds (Sloman et al., 2017). The last study did not give specific details on the duration outside of the fact that it was implemented 3-5 times a week during the same classroom activities (Liu-Gitz & Banda, 2010).

Interobserver Agreement

Four studies reported 94% or higher IOA for each participant (Liu-Gitz & Banda, 2010; Martinez et al., 2016 study 2 and 3; Saini et al., 2015), two reported 92-94% (Pastrana et al., 2013; Sloman et al., 2017), three reported 86-89% (Carroll & Kodak, 2014; Dickman et al., 2012; Martinez et al., 2016), and the last two reported 80-86% (Carroll & Kodak, 2014; Shawler & Miguel, 2015). Each study broke their interobserver agreement up by participant. Further,

within each study that had more than one type of stereotypy, they reported interobserver agreement for each type of stereotypy that was being tracked for each child.

Designs

All 11 studies were single-case designs. Three of these studies utilized alternating treatment designs (Carroll & Kodak, 2014; Pastrana et al., 2013), six studies utilized reversal designs (Dickman et al., 2012; Liu-Gitz & Banda, 2010; Martinez et al., 2016 (study 2 and 3); Saini et al., 2015; Shawler & Miguel, 2015), and two studies utilized multiple baseline designs (Martinez et al., 2016 (study 1); Sloman et al., 2017).

Outcomes

I calculated PND for all 11 studies. Based on the criteria from Scruggs and Mastropieri (1998), three studies were highly effective for all participants (Liu-Gitz & Banda, 2010; Shawler & Miguel, 2015; Sloman et. al., 2017), four studies were effective for all participants (Dickman et al., 2012; Martinez et al., 2016), and the remaining four studies were variable by participant (Carroll & Kodak, 2014; Pastrana et al., 2013; Saini et al., 2015). RIRD was highly effective for one participant and effective for the other participant according to PND for three studies (Carroll & Kodak, 2014; Saini et al., 2015). In one article RIRD was considered questionable for one participant and ineffective for one participant (Pastrana et al., 2013).

Overall, 10 out of the 11 studies reported positive results according to PND. Stereotypy was decreased for 20 out of the 21 participants. In the study by Shawler and Miguel (2015), data for one participant indicated that neither VRIRD or MRIRD were effective at decreasing his vocal stereotypy. For another participant in this study only moderate reductions in stereotypy were observed. These two participants were 7 and 12 years old, respectively. The remaining

participants across studies showed significant reductions in stereotypy and ranged in age from 5 to 13-years-old.

DISCUSSION

My systematic search produced 11 studies containing intervention variations of RIRD to address vocal and motor stereotypy, with one of those being a prior synthesis. Summaries of the studies revealed that RIRD is a new intervention in the field of research. All articles were published between the summer of 2007 and fall of 2017.

Based on this review of studies it was concluded that the published studies support the use of RIRD for both motor and vocal stereotypy in individuals diagnosed with an ASD. Below are some of the limitations with the studies that were reviewed in terms of problems with validity and other possible explanations for the success of RIRD as well as an overall summary and future directions for research.

Problems with Validity

One article reported the results of two studies (i.e., Carroll & Kodak, 2014) that reported effective outcomes for the clients in both studies, but did not report any procedural integrity. Procedural integrity plays a major role in the effectiveness of behavioral interventions because it is used to confirm the validity of the independent variable. The lack of procedural integrity makes it difficult to conclude that the positive outcomes on the clients were directly related to the RIRD procedure because there is no reliable measure of the independent variable (Mitchell, 2010). One study began implementation of RIRD after baseline had an upward trend (i.e., Liu-Gitz & Banda, 2010). Baseline data trends should be relatively stable prior to implementing an

intervention to allow for a valid condition with which to compare the results of the treatment condition. Another study (i.e., Pastrana et al., 2013) did not follow the initial RIRD protocol of providing attention and reinforcement for appropriate speech. Providing attention and reinforcement for appropriate speech was a vital component of many RIRD studies (e.g., Ahearn et al., 2007; Ahrens et al., 2011; Dickman et al., 2012; Liu-Gitz & Banda, 2010) because it ensured that the child's appropriate speech was not extinguished during the study. Not providing attention for appropriate speech could have caused RIRD to be less effective than in previous studies (e.g., Ahearn et al., 2007; Ahrens et al., 2011; Dickman et al., 2012; Liu-Gitz & Banda, 2010) because reductions in all vocalizations may have resulted instead of reductions in just inappropriate vocalizations. Because it is likely that reinforcing appropriate vocalizations may enhance the effectiveness of RIRD, not reinforcing them could have an adverse effect on the RIRD, thus causing a problem with internal validity.

Three studies did not implement FAs to determine the function of the behavior prior to implementation (i.e., Carroll & Kodak, 2014; Liu-Gitz & Banda, 2010; Pastrana et al., 2013). An FA is conducted to determine the function of the stereotypy (i.e., the antecedents that are occasioning the behavior and the reinforcers that are maintaining the behavior). Ahearn et. al. (2007) stated that RIRD was designed as an intervention meant to address stereotypic behaviors that are maintained by sensory stimulation (i.e. has an automatic function of behavior) by response blocking and causing sensory extinction. It is important to note that they state despite implementing sensory extinction, the results of the procedure are related to punishment and not extinction (Ahearn et. al., 2007; Lerman & Iwata, 1996). Without completing an FA to know if the function is automatic, it is not possible to know whether RIRD is an appropriate intervention

for the stereotypy. RIRD could reinforce the behavior if the function was attention, tangible, or escape; thus causing the intervention to be less effective. Future studies should all ensure that the stereotypy is automatically reinforced prior to implementing RIRD to address it.

Possible Explanations for Study Outcomes

RIRD could show a decrease in stereotypy due to less time available for the child to engage in such behaviors because of the amount of time RIRD takes during implementation. Pastrana et al. (2012) stated that this was not likely to decrease stereotypy if data was collected both within and outside of the RIRD protocol because there was still the possibility of the children engaging in stereotypy during RIRD implementation. They also stated that implementation time of RIRD during the sessions was generally brief and did not take much of the overall intervention time. Despite the explanation provided by Pastrana et al. (2012), future studies should ensure they also collect data on RIRD during implementation of RIRD in order to control for this potential explanation of positive study outcomes. Carroll and Kodak (2014) controlled for time of implementation by collecting data during and outside of the RIRD treatment. The authors collected and compared data in terms of treatment time and non-treatment time and their analysis showed that RIRD did not effectively decrease vocal stereotypy. Further, the individual continued to engage in vocal stereotypy during a considerable portion of sessions. When studies collect data both within and outside of the implementation of RIRD their data collection measures more accurately depict what was collected during baseline. This is because data on stereotypy is collected throughout the entire duration of the session during baseline. If data is not collected during the implementation of RIRD then data is not being collected for the entire duration of the intervention session. Collecting data both within and outside of

implementation of RIRD will assist in being able to directly compare the baseline and intervention sessions.

There are many components involved in implementing RIRD, thus it can be difficult to separate each component in terms of attributing decreases in vocal stereotypy without completing a component analysis. Various RIRD procedures include (a) RIRD plus a no-interaction (NI) component (i.e., Carroll & Kodak, 2014; Pastrana, Rapp, & Frewing, 2013; Schumacher & Rapp, 2011), (b) RIRD plus a non-contingent reinforcement (NCR) component (i.e., Carroll & Kodak, 2014), (c) RIRD plus a differential reinforcement of incompatible behaviors (DRI) component (i.e., Dickman, Bright, Montgomery, & Miguel, 2012), and (d) signaled RIRD (i.e., Sloman, Schulman, Torres-Viso, & Edelstein, 2017). Carroll and Kodak (2014) conducted an alternating treatments design to compare the effects of RIRD, NCR, and NI components. However, Carroll an Kodak (2014) compared the data-analysis procedures of each component instead of the component itself. In other words, they compared the data collection of RIRD, NCR, and NI in terms of interrupted vs. uninterrupted data analysis. Since they were implementing different data-collection procedures for each component you cannot directly compare the RIRD, NCR, and NI components because data was not collected the same way for each component. Martinez et al. (2016) stated that future research should continue to investigate signaled RIRD to increase generalization across settings because the signaled component could greatly improve the generalizability of RIRD. Despite Carroll and Kodak's data-analysis comparison and Martinez et al. assertions regarding signaled RIRD, a formal component analysis has yet to be conducted in any published article to determine the relative effects of NI, NCR, DRI, and signaled RIRD components. Future research should include a component analysis of

these components by directly comparing components such as RIRD, NI, NCR, DRI, and signaled RIRD. This is necessary to determine which component(s) may add to the effectiveness or generalizability of RIRD.

Summary and Future Directions

Similar to the previous synthesis conducted by Martinez and Betz (2013), the results of this review show that there is strong support for the use of RIRD to decrease both vocal and motor stereotypy. Results pertaining to the topography of the demand are also similar to previous results in that there has been further research to show that there was not a significant difference between using motor demands or vocal demands to address vocal stereotypy when implementing RIRD.

Martinez and Betz (2013) stated that future research should evaluate the effects of RIRD in longer durations and in the natural environment. Martinez et al. (2016) addressed both by implementing RIRD for 30-min sessions in the participant's classroom. The participant maintained low levels of vocal stereotypy for longer durations and during typical activities thereby demonstrating clinical significance and social validity (i.e., feasible to implement RIRD with individuals in typical settings for longer durations). One limitation of Martinez et al. is that the "natural environment" classroom only contained three children and each were receiving 1:1 individualized services. Due to the layout of the participant's classroom, we cannot generalize these results to a typical classroom setting that has high student-to-teacher ratios, different activities occurring throughout the room, and myriad other distractions. Future research should extend Martinez et al. and other studies in this area of research by evaluating the implementation of RIRD during longer durations and in natural environments with typically developing peers.

This should be done with more participants, while being implementing during an entire school day; and with adults (i.e. teachers) implementing the procedures in the typical environment.

Liu Gitz and Banda (2010) implemented RIRD in a special education classroom successfully but did not generalize the treatment into the general education classroom or home; nor did the authors evaluate whether the results generalized across settings, time, or other individuals. Although the results were positive, in the special education classroom environment, there are fewer students, more teachers, and instruction is individualized to each student. Thus, the special education classroom lacks many of the distractions and barriers to learning that are present in the classroom with typically developing peers. Future studies should evaluate effectiveness and feasibility of RIRD in general education classroom settings and home environments.

Martinez and Betz (2013) also stated that future research should systematically evaluate the response requirement for RIRD. Saini et al. (2015) did this when they compared the effects of RIRD with one demand (RIRD 1) and RIRD with three demands (RIRD 3). They did not require independent compliance, but instead they physically prompted compliance when necessary. The results of Saini et al. showed that RIRD 1 and RIRD 3 both resulted in clinically significant levels of reduction in stereotypy. It was also found that RIRD 1 was effective at maintaining low levels of stereotypy. Future research should compare the difference in prompting compliance vs. requiring independent compliance for the different number of demands.

Lastly, future research should also look at doing a longitudinal study to determine the lasting effects that an RIRD intervention may have on the individual. Martinez et al., (2016)

conducted 3- and 8-week follow-ups in the classroom setting during their Study 2. Both follow-ups showed that vocal stereotypy remained low. One limitation of Martinez et al. was that they were unclear in their description as to whether RIRD was still being implemented in the classroom with the 1:1 teacher in the time between the end of their study and the follow-up component. To date, Martinez et al. is the only study that has conducted follow-up sessions for RIRD. No other studies have shown that stereotypy continues to remain at low levels after extensive time has passed since RIRD was implemented. Since most stereotypy is maintained by automatic reinforcement, it is likely that over time it will continue or increase back to previous levels or higher. Future research should account for the above-mentioned limitations when doing a longitudinal study by conducting follow-up evaluations when RIRD is being implemented by adults in the typical setting after the study has ended and when RIRD is not implemented at all in the time between the end of the study and the follow-up.

Chapter 3: Methods

The methods for experiments are described, including (a) participants, settings, and materials, (b) dependent variables, (c) measurement, (d) interobserver agreement (IOA), (e) experimental design, and (f) independent variables.

PARTICIPANTS, SETTINGS, AND MATERIALS

There were three participants in this study, Raja, Krishna, and Nandan. All participants had an official autism diagnosis from a medical provider and no other known diagnoses. The first participant, Raja, was a 4-year-old boy of Indian descent. Raja was able to communicate his wants and needs in 3+ word sentences and maintain very short conversations with adults. He did not engage in verbal communication with peers without prompting. Parents did not speak their native language to Raja in home. Raja had functional toy play with a variety of toys and early signs of pretend play. However, due to Raja's severe aggression and interfering behaviors he could not maintain engagement in play for more than a few minutes at a time. Raja attended a private preschool that was partnered with his ABA clinic. He was in an inclusion pre-k classroom 5 days a week. The initial functional analysis along with the first three sessions were run in a 10 x 5 foot rectangle area of a larger typical classroom during the day when the children were not in the room. The 10 x 5 foot area was blocked off from the rest of the room by tables and bookcases. The classroom included 4 doors, one that was within the 10 x 5 foot area. Due to the client's severity of aggression, property destruction, and eloping, starting at the 4th session all sessions were moved to a small 5 x 5 foot area of the library. The 5 x 5 foot area of the library was blocked off by a puppet stage with a black sheet so nothing on the other side of the library

was visible to the participant. All sessions were run at Raja's private preschool. Raja was on a special diet that consisted of only organic fruits, vegetables, and meat. His was not allowed sugar or carbohydrates. He had been on this diet for 11 months prior to the start of this study. He was not on any psychotropic medications.

The second participant, Krishna, was a 5-year-old boy of Indian descent. Krishna was able to say all sounds and words in the English language when prompted either verbally or in writing. He could read at a 3rd grade level. He engaged in minimal functional independent communication. All communication was done in English. Parents did not speak their native language around Krishna. Krishna had minimal functional play skills with most toys (e.g. cars, dolls, train tracks, blocks, etc.), but he could maintain functional play for short periods of time with art activities/supplies, gross motor activities, fine motor activities, books, playdoh, and anything with letters or numbers. Krishan attended an ABA clinic 32.5 hours a week and participated in inclusionary activities with typical peers for outdoor play only. Krishna was not on any special diets or psychotropic medications.

The third participant, Nandan, was a 4-year-old boy of Indian descent. Nandan had a minimal verbal English repertoire as his main form of communication. He required verbal prompting to engage in most communication. Parents did not speak their native language to Nandan, but did speak it around him in the home. Nandan was able to engage in functional play with preferred toys for short periods of time but required frequent prompting and redirection from behaviors such as pica. Nandan attended an ABA clinic 32.5 hours a week. He was not on any special diets or psychotropic medications.

The functional analysis and all intervention sessions for Krishna and Nandan were run in a 10 x 20 foot rectangle area of a larger typical classroom during the day when the children were not in the room. The 10 x 20 foot area was blocked off from the rest of the room by a smart table. There were no doors within the 10 x 20 foot area and the only exit to the main classroom was blocked due to the location of the smart table. All sessions for all participants were conducted by the lead experimenter. Materials for all participants included preferred items identified by stimulus preference assessments and current and mastered materials from their ABA programs. No materials utilized in his intervention were isolated to intervention sessions only.

DEPENDENT VARIABLES, MEASUREMENT, AND DATA COLLECTION

Motor and vocal stereotypy were the primary dependent variables in the treatment evaluation. All participants engaged in both types of stereotypy with different topographies. Rate per minute and percentage of session engaged in stereotypy was calculated for both motor and vocal stereotypy.

For the signaled RIRD sessions both interrupted and uninterrupted data collection measures were used. The interrupted data collection measures included only instances of stereotypy that occurred when the green was not present (i.e. when stereotypy was not allowed). The uninterrupted data collection measures included instances of stereotypy that occurred throughout the entire session, both when the green paper was and was not present.

Response Definitions

For Raja, the operational definition for vocal stereotypy was any instance in which he engaged in any vocalization, including words, songs, and phrases, not applicable to that situation separated by 10 or more seconds of non-occurrence. Spontaneous labeling (i.e. when he would pick up a car and say "it's a car" or point to a chair and say "chair") was not included in stereotypy due to it being a new targeted skill acquisition goal. Raja's operational definition for motor stereotypy was any instance of the him engaging in repetitive body motor actions, such as waving arms, wiggling fingers, and drawing things in the air with his finger, which may or may not occur in front of his face.

For Krishna, the operational definition of vocal stereotypy was any instance in which he engaged in repetitive vocalizations that were repeated more than two times or lasted more than 10-seconds (i.e. "mananananaandadada" or "letters letters letters letters"), including sounds and words, not applicable to the situation separated by 10 or more seconds of non-occurrence. Krishna's operational definition of motor stereotypy is repetitive motor movements, including but not limited to body tensing, hand flapping, sitting on heels and body rocking, and pacing, not applicable to the situation and separated by 10 or more seconds of non-occurrence.

For Nandan, the operational definition of vocal stereotypy was any instance of him engaging in nonsensical and/or non-functional sounds and/or screaming. At times it sounded as if Nandan was speaking in another language. Since his parents noted that they did speak the language around him, even though they did not speak it directly to him, his parents were consulted regarding this to ensure communication in another language was not targeted as stereotypy. Parents confirmed while he makes the correct sounds and cadences for their native

language, he is not actually saying anything. Parents confirmed he did not speak any words in their native language so all instances of speech that sounds like their language are instances of stereotypy. The operational definition for motor stereotypy was any instance of shaking items/hands, may or may not be close to his face, quickly blinking his eyes, jumping, doing full arms in a forward and backward motion, and/or shaking his head.

Instances of motor and vocal stereotypy were counted and converted to rate per minute by dividing the count by the total duration of the session. Duration of motor and vocal stereotypy was calculated and converted to percentage of session engaged in stereotypy by dividing the duration in minutes by the total duration in minutes and multiplying by 100.

INTEROBSERVER AGREEMENT

A trained observer independently viewed videos and coded data during 30.42% of all sessions randomly selected across all phases of the intervention and all participants. IOA was calculated for each session utilizing total count IOA and total duration IOA. Total count IOA was calculated by dividing the small total count observed by the larger total count observed and multiplying it by 100. Total duration IOA was calculated by taking the sum of each observer, dividing the shorter of the two durations by the longer duration, and multiplying it by 100. Session IOAs were summed and converted into a mean IOA for both total count IOA and total duration IOA and both motor and vocal stereotypy. Mean total count IOA for motor stereotypy was 89.99% (range, 75-100%). Mean total count IOA for vocal stereotypy was 80.61% (range, 70-94.14%). Mean total duration IOA for motor stereotypy was 93.04% (range, 76.47-100%). Mean total duration IOA for vocal stereotypy was 83.44% (range, 79.06-87.5%).

EXPERIMENTAL DESIGN AND INDEPENDENT VARIABLES

Preference Assessment

A free operant preference assessment was conducted with each participant. This type of assessment was chosen for multiple reasons: (1) due to the ease of implementation in a classroom type setting, (2) due to a history of aggression and challenging behavior from each participant, and (3) due to a history of each participant to have an inability to choose between high-preferred and low-preferred items. In the assessment each participant was put in a room with 1-2 dozen preferred items based on parent and therapist reports. All items were placed within reach of the child and they were allowed free access to all toys. The child was watched for 10 minutes, or until they stopped engaging in play with toys. The number of times they chose to engage with each toy/activity was counted as well as the duration spent with each toy/activity.

Functional Analysis (FA)

A multielement brief functional analysis utilizing attention, demand, play, and alone conditions (Iwata et al., 1982/1994) was conducted prior to the intervention for each participant. The purpose of the FA was to determine the function of each participants stereotypy. The lead experimenter implemented all functional analysis conditions. Each session was 5-minutes in length with a 1-minute break between sessions. The attention and play conditions contained the toys identified in the preference assessment for each participant. The demand condition utilized the child's current ABA programming.

During the attention condition the room had preferred toys. The experimenter walked in the room and told the child that they could play while the experimenter finished some work. The experimenter then went to go sit to the side of the designated area and pretended to be busy working on an ipad, computer, or doing paperwork. Every time the child engaged in the target behavior the experimenter gave attention telling them to stay quiet for vocal stereotypy and stay still for motor stereotypy.

During the play condition the experimenter entered the room with the child's preferred items set up and engaged in play with the child. Non-contingent attention was given throughout the duration of the 5 minutes and all target behaviors were ignored.

During the demand condition the experimenter walked in with the child and said it was time for work. They implemented the child's current ABA programming as demands for the child to comply with throughout the duration of the 5 minutes. Contingent upon each occurrence of the target behavior the experimenter withdrew the demand and turned their back for 30 seconds. After 30 seconds had passed, the experimenter turned around and immediately began "working" with the child again.

During the alone condition the experimenter put the child in the room alone and "left". The child was always observed and monitored through a camera or window. This condition was utilized to see if the stereotypic behaviors persisted in the absence of social consequences.

INTERVENTION

General Procedures

A multielement single subject research design was used to evaluate the effectiveness of the study. A treatment evaluation occurred using the following treatment conditions: RIRD, signaled RIRD, and VR schedule of response reductive strategy to decrease stereotypy. All sessions were 10 minutes in length during the intervention phase of the study. A free-operant preference assessment was conducted to determine the child's preferred toys/activities prior to the sessions. If a child did not show interest in a toy/activity during the session or voiced a dislike, then the preference assessment would be run again prior to the following session.

For Raja, each 10-minute session included "work" and play. His work consisted of his current ABA programming ran as it was in the demand portion of the FA. Due to the severity of Raja's aggression and inability to consistently engage in any one activity for more than a few minutes his sessions were split 50/50 with sessions consisting of half work and half play across the duration of the session. For example, some sessions were split 5 minutes work followed by 5 minutes play and others were split 2 minutes work, 3 minutes play, 3 minutes work, and 2 minutes play. Raja's aggression was not to be addressed during the sessions. All aggression was put on extinction by ignoring it and continuing the demand. Physical blocking would be used for safety purposes only while continuing the demand until compliance was achieved. If at any point aggression increased and caused either himself or the lead experimenter to bleed the session would be immediately discontinued. No sessions had to be discontinued due to aggression during

this study. All other challenging behaviors were to be ignored and child redirected back to activity.

For all other participants, each session consisted of play with preferred items based on their preference assessment for the entire 10 minutes. All untargeted challenging behaviors were to be ignored and the child redirected back to the activity.

RIRD

The purpose of this condition was to assess the effects of RIRD on stereotypy. RIRD consisted of interrupting the participant's stereotypy by physically guiding them to stop motor stereotypy, asking questions, or giving echoic tasks to stop vocal stereotypy. The participant was then given a series of three mastered tasks that can include vocal imitation, intraverbal, motor imitation, or receptive tasks. The child was required to independently comply with all three tasks prior to being redirected back to the activity. If the child was non-compliant then they were physically guided to comply with each demand until they independently completed all three. Following successful, independent completion of the three tasks, the participant was redirected back to the original activity. RIRD was implemented contingent of each instance of stereotypy throughout the duration of the session.

Signaled RIRD

The purpose of this condition was to assess the effects of discrimination training on stereotypy. Signaled RIRD procedures utilized green paper and a phrase when they could not engage in stereotypy. A green paper was utilized by making it visible to the child when they had

access to engage in stereotypy without RIRD being implemented. When the green paper was not visible it signaled to the child that they did not have access to engage in stereotypy, thus RIRD was implemented for every instance of stereotypy. Specific phrases were utilized in the same manner as the green paper. The phrase “green is out” signaled to the child that they had access to engage in stereotypy without being blocked. The phrase “green is gone” signaled to the child that they did not have access to engage in stereotypy, thus RIRD was implemented for every instance of stereotypy.

Variable Ratio (VR) of RIRD

The purpose of this condition was to assess the effectiveness of an inconsistent implementation of RIRD on stereotypy. A VR schedule of response reductive strategy was utilized by implementing RIRD as stated above. However, these sessions implemented RIRD on a VR schedule throughout the entire session time. The VR schedule was VR2 for all participants. In the VR2 schedule the response reductive strategy was implemented an average of every two instances of stereotypy. Thus, it could be implemented the first time the child engages in stereotypy and then not again until after three more instances because that would average to two.

Chapter 4: Results

In this chapter, the results of each phase of the study are presented. The first section includes the results for the preference assessments for each participant. The next section includes the results from the functional analysis for each participant. Finally, the results from the intervention are presented for each participant.

PREFERENCE ASSESSMENT

For Raja, the results of the free operant preference assessment showed a high preference for books based on songs (e.g. “Mary Had a Little Lamb”, “The Ants go Marching”, “Miss Mary Mack,” and “The Eensy Weensy Spider”), a book called *Don’t Eat Your Classmates*, *Pete the Cat*, writing with dry erase markers, playing with blocks, and dolls.

The results of the free operant preference assessment for Krishna showed a high preference for a *Sesame Street Elmo* letter suitcase, a *Sesame Street Cookie Monster* number suitcase, a Letter Factory Perfection game.

The results of the initial free operant preference assessment for Nandan showed high preference for cars, finger puppets, and little people animals. Due to Nandan’s frequent changes in preferences a new free operant preference assessment was implemented every two sessions to maximize maintenance of motivation throughout the functional analysis and intervention. A high preference for cars, construction vehicles, trains, train tracks, building sticks, finger puppets, play-doh, little people animals, little people, little people bus, and a little people car ramp was demonstrated throughout the study.

FUNCTIONAL ANALYSIS

The results of the functional analysis pertaining to vocal stereotypy for Raja are shown in Figure 1. A clear differentiated pattern of vocal stereotypy in terms of engagement was demonstrated. Specifically, vocal stereotypy occurred during a high percentage of the session during the alone condition with a decreasing trend (M = 49.11%). Low percentages of engagement in vocal stereotypy were observed during the play (M = 0.44%), demand (M = 11.67%), and attention (M = 16.89%) conditions.

Figure 2 depicts the motor stereotypy results of the functional analysis for Raja. In figure 2, the percentage of session engaged in motor stereotypy is shown. Motor stereotypy occurred in a higher percentage of session in the alone (M = 5%) condition and a lower percentage of the session in the attention (M = 0%), demand (M = .11%), and play (M = .11%) conditions. These results suggest that both Raja's vocal and motor stereotypy were maintained by automatic reinforcement.

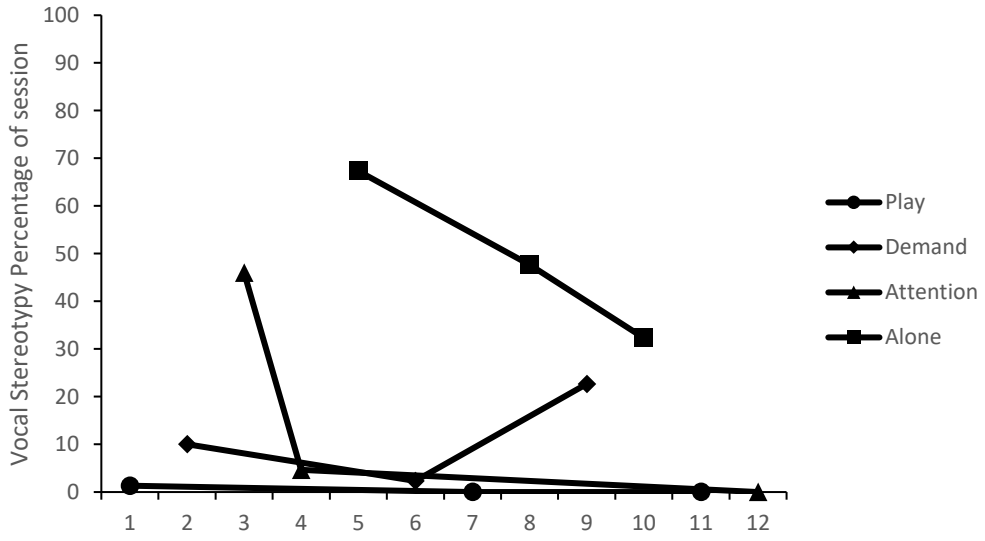

Figure 1. Vocal stereotypy during the functional analysis for Raja.

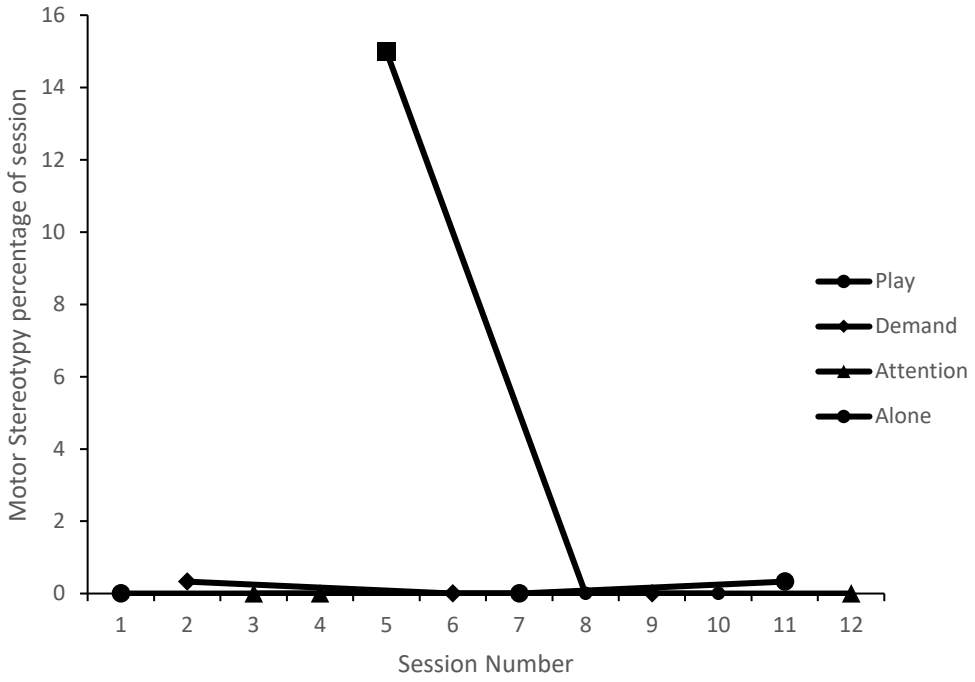

Figure 2. Motor stereotypy during the functional analysis for Raja.

The results of the functional analysis pertaining to vocal stereotypy for Krishna are shown in Figure 3. An undifferentiated pattern of vocal stereotypy in terms of engagement was demonstrated. Specifically, vocal stereotypy occurred during a high percentage of the session during the attention condition with a decreasing trend (M = 1.61%) and the play condition with no trend (M = 1.28%) conditions. Vocal Stereotypy occurred in the lowest percentage of session in

the alone condition with no trend (*M* = .72%) and demand condition with a decreasing trend (*M* = .44%).

The results of the functional analysis pertaining to motor stereotypy for Krishna are displayed in Figure 4. An undifferentiated pattern of vocal stereotypy in terms of engagement was demonstrated. Motor stereotypy occurred in a higher percentage of the session in the alone condition (*M* = 5.11%), play condition (*M* = 13.54%), and attention condition with a decreasing trend (*M* = 6.22%). Motor stereotypy occurred in a lower percentage of session in the demand condition with a decreasing trend (*M* = .22%). These results suggest that both Krishna's vocal and motor stereotypy were maintained by automatic reinforcement.

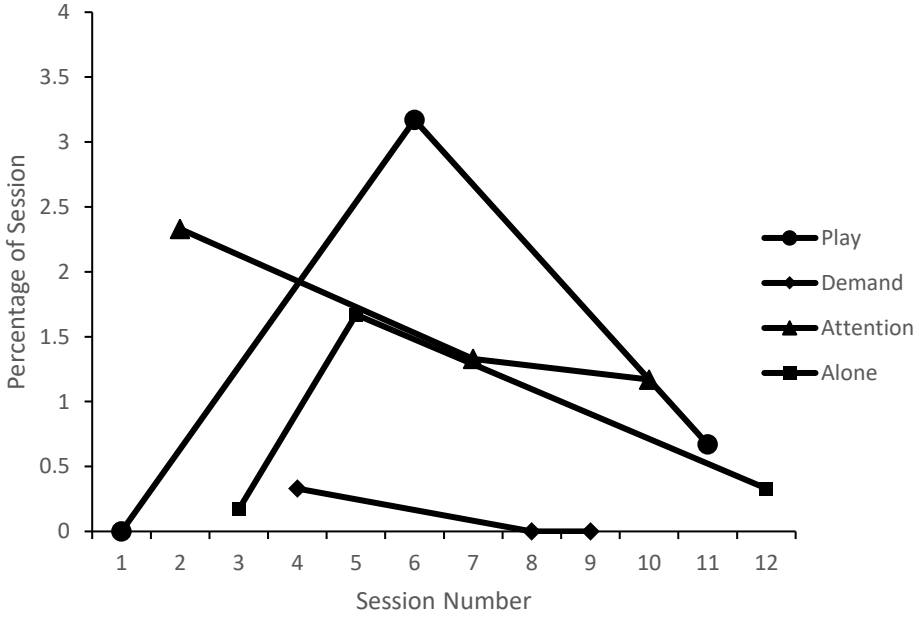

Figure 3. Vocal stereotypy during the functional analysis for Krishna.

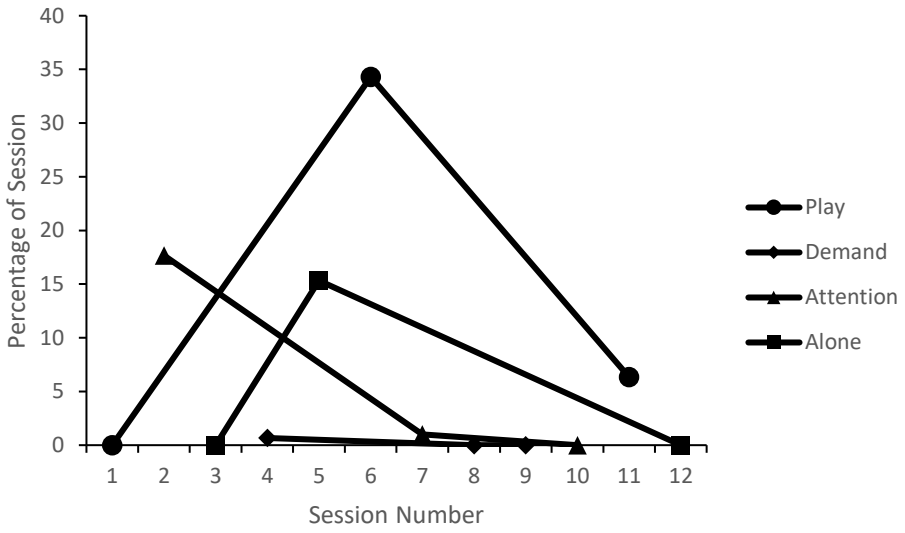

Figure 4. Motor Stereotypy during the functional analysis for Krishna.

The results of the functional analysis pertaining to vocal stereotypy for Nandan are shown in Figure 5. A clear differentiated pattern of vocal stereotypy results was demonstrated. Vocal stereotypy occurred during a high percentage of the session during the play condition with a stable trend (M = 85.87%). Lower percentages of engagement in vocal stereotypy were observed during the attention condition with a stable trend (M = 68.42%), alone condition with a slightly variable, yet decreasing trend (M = 54.33%), and demand condition with a decreasing trend (M = 45.78%).

Figure 6 depicts the motor stereotypy results of the functional analysis for Nandan. In Figure 6, the percentage of session engaged in motor stereotypy is shown. An undifferentiated pattern of motor stereotypy in terms of engagement was demonstrated. Motor stereotypy occurred in a low percentage of the session in the alone condition (M = .33%), attention condition with a slightly increasing trend (M = 1.11%), demand condition with a decreasing trend (M = .78%), and

play condition with a decreasing trend (M = 2.89%). These results suggest that both Nandan's vocal and motor stereotypy were maintained by automatic reinforcement.

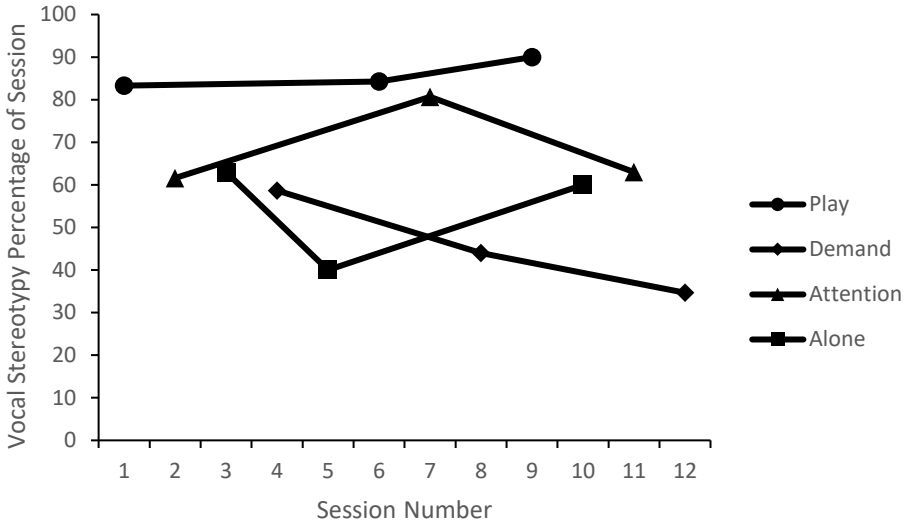

Figure 5. Vocal stereotypy during the functional analysis for Nandan.

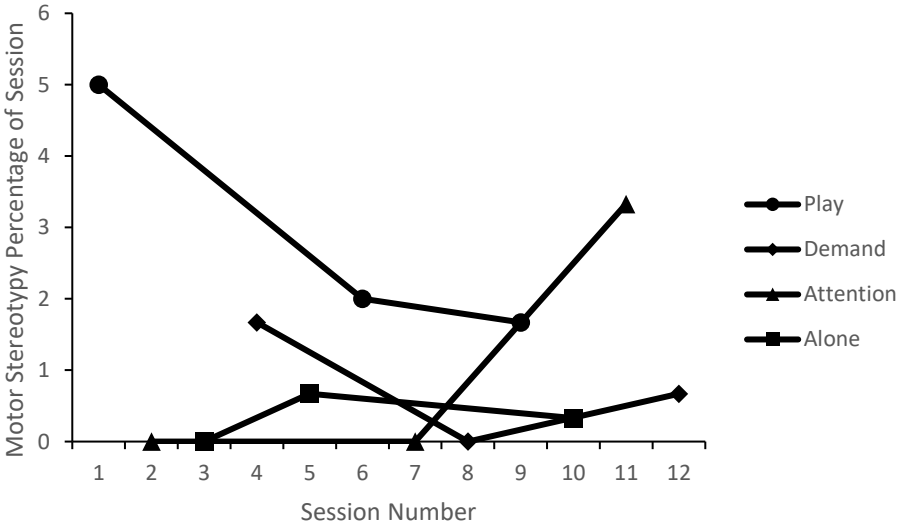

Figure 6. Motor Stereotypy during the functional analysis for Nandan.

TREATMENT EVALUATION

Raja

Figure 7 displays the results of the treatment evaluation in terms of engagement in vocal stereotypy (Figure 7 includes the total stereotypy that occurred during the Signaled RIRD condition [i.e., data include responding that occurred in the presence *and* absence of the green card]). Percentages of vocal stereotypy were highest during the RIRD condition (M = 12.31%) relative to the VR-RIRD (M = 7.98%) and Signaled RIRD (M = 8.06) conditions. Although the results of the VR-RIRD and Signaled RIRD conditions were initially undifferentiated, vocal stereotypy eventually decreased in the Signaled RIRD condition relative to the VR-RIRD condition. The results of the evaluation were similar when data in the Signaled RIRD included only those instances of stereotypy that occurred when the green card was absent (Figure 8).

Figure 9 displays the results of the treatment evaluation in terms of engagement in motor stereotypy (Figure 9 includes the total stereotypy that occurred during the Signaled RIRD condition [i.e., data includes responding that occurred in the presence *and* absence of the green card]). No instances of motor stereotypy occurred during the RIRD and Signaled RIRD conditions. Low levels of motor stereotypy (M = 0.2%) occurred during the VR RIRD condition. When expressed as responses per minute (not graphed), the results of the treatment evaluation were similar to those expressed as percentage of session. The results of the evaluation were

identical when data in the Signaled RIRD condition included only those instances of stereotypy that occurred when the green card was absent (Figure 10).

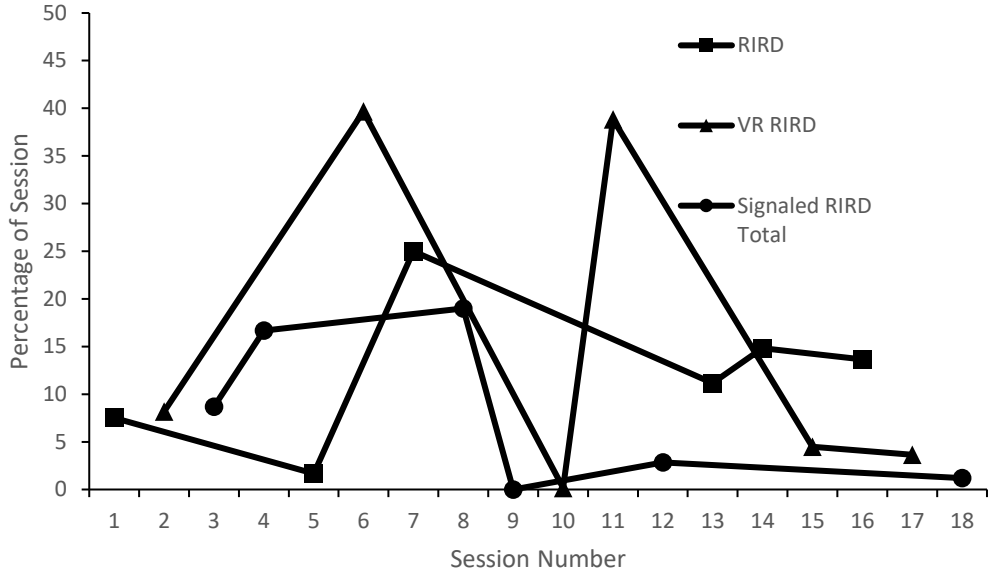

Figure 7. Vocal stereotypy during the treatment evaluation (occurrences of vocal stereotypy that occurred during the entire session in the Signaled RIRD condition [i.e., regardless of the presence or absence of the green card]) for Raja.

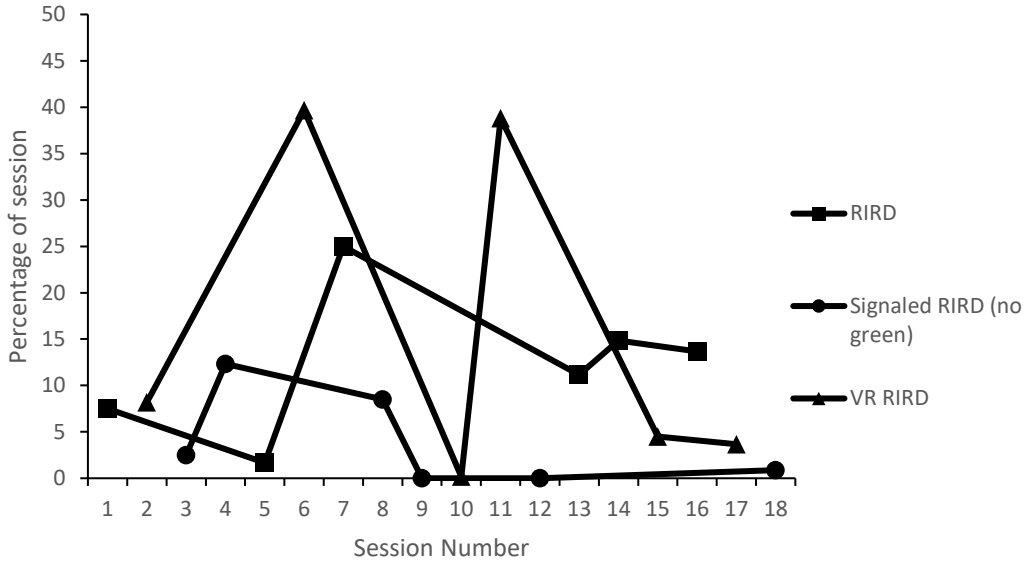

Figure 8. Vocal stereotypy during the treatment evaluation (occurrences of vocal stereotypy when the green card was absent during the Signaled RIRD condition) for Raja.

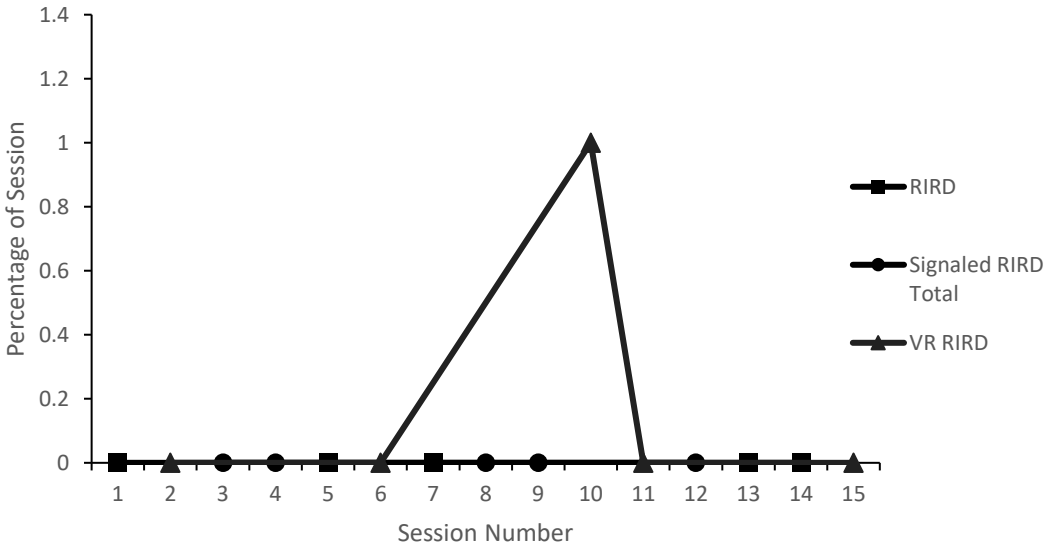

Figure 9. Motor stereotypy during the treatment evaluation (occurrences of vocal stereotypy that occurred during the entire session in the Signaled RIRD condition [i.e., regardless of the presence or absence of the green card]) for Raja

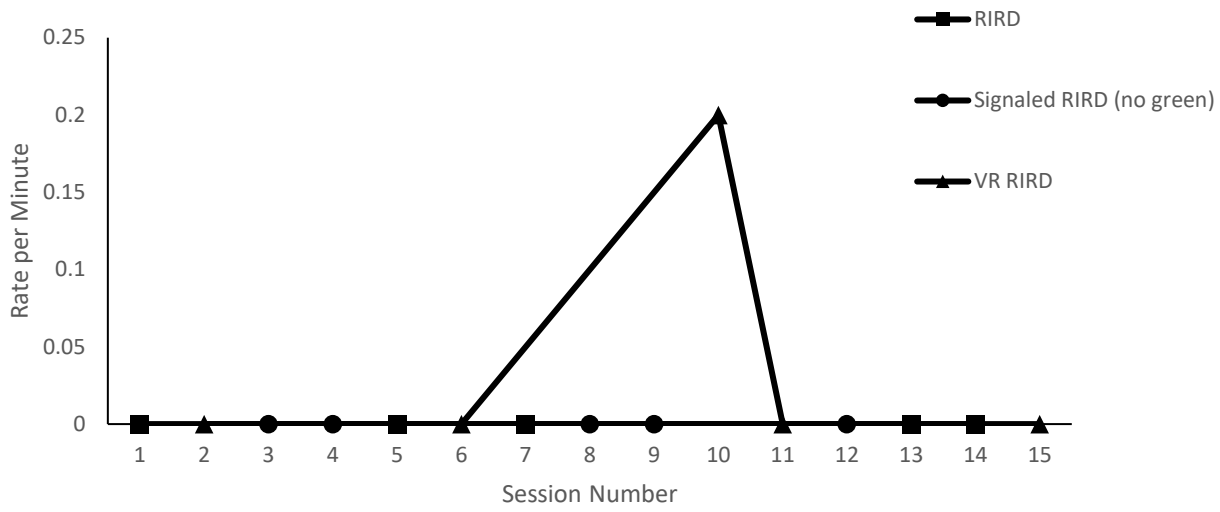

Figure 10. Motor stereotypy during the treatment evaluation (occurrences of motor stereotypy when the green card was absent during the Signaled RIRD condition) for Raja.

Krishna

Figure 11 displays the results of the treatment evaluation in terms of engagement in vocal stereotypy (Figure 11 includes the total stereotypy that occurred during the Signaled RIRD condition [i.e., data include responding that occurred in the presence *and* absence of the green card]). Krishna engaged in vocal stereotypy during less than 1% of all sessions across conditions and data collection measures. Percentage of vocal stereotypy was highest during the VR RIRD condition (M = .83) relative to the RIRD (M = .59%) and Signaled RIRD (M = .07%) conditions. The results of the evaluation were similar (M = .13%). when data in the Signaled RIRD condition included only those instances of stereotypy that occurred when the green card was absent (Figure 12).

Figure 13 displays the results of the treatment evaluation in terms of engagement in motor stereotypy (Figure 13 includes the total stereotypy that occurred during the Signaled RIRD condition [i.e., data includes responding that occurred in the presence *and* absence of the green card]). Percentages of vocal stereotypy were highest during the VR RIRD (*M* = 5.13%) and during the Signaled RIRD (*M* = 2.84%) conditions. The lowest engagement in motor stereotypy was during the RIRD condition (*M* = .99%). The results of the evaluation were significantly lower when data in the Signaled RIRD condition included only those instances of stereotypy that occurred when the green card was absent (*M* = .79%; Figure 14).

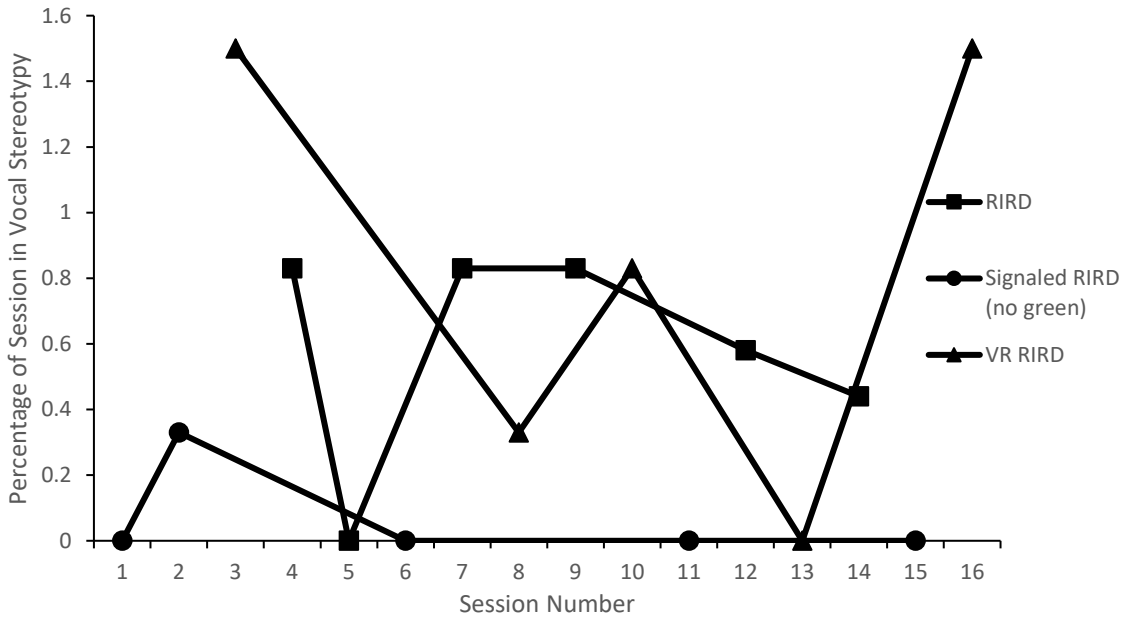

Figure 11. Vocal stereotypy during the treatment evaluation (occurrences of vocal stereotypy that occurred during the entire session in the Signaled RIRD condition [i.e., regardless of the presence or absence of the green card]) for Krishna.

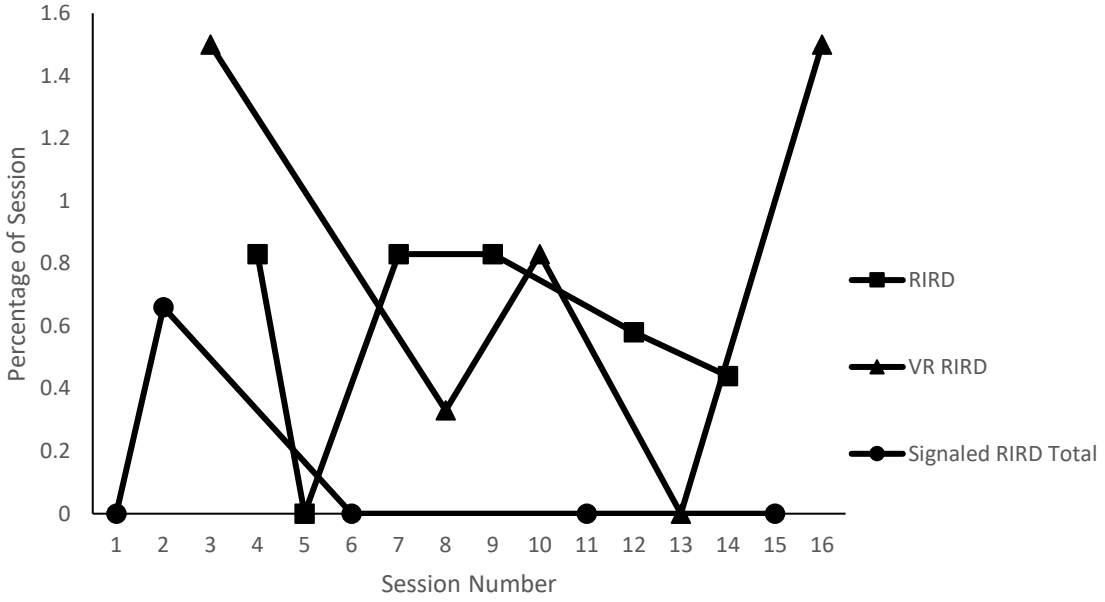

Figure 12. Vocal Stereotypy during the treatment evaluation (occurrences of vocal stereotypy when the green card was absent during the Signaled RIRD condition) for Krishna.

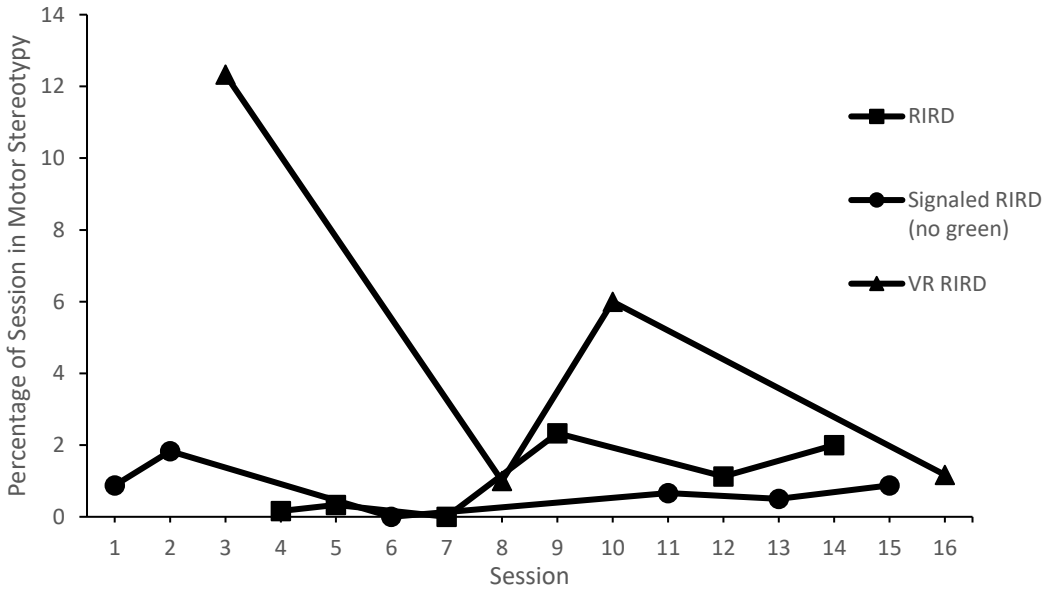

Figure 13. Motor stereotypy during treatment evaluation (occurrences of vocal stereotypy that occurred during the entire session in the Signaled RIRD condition [i.e., regardless of the presence or absence of the green card]) for Krishna.

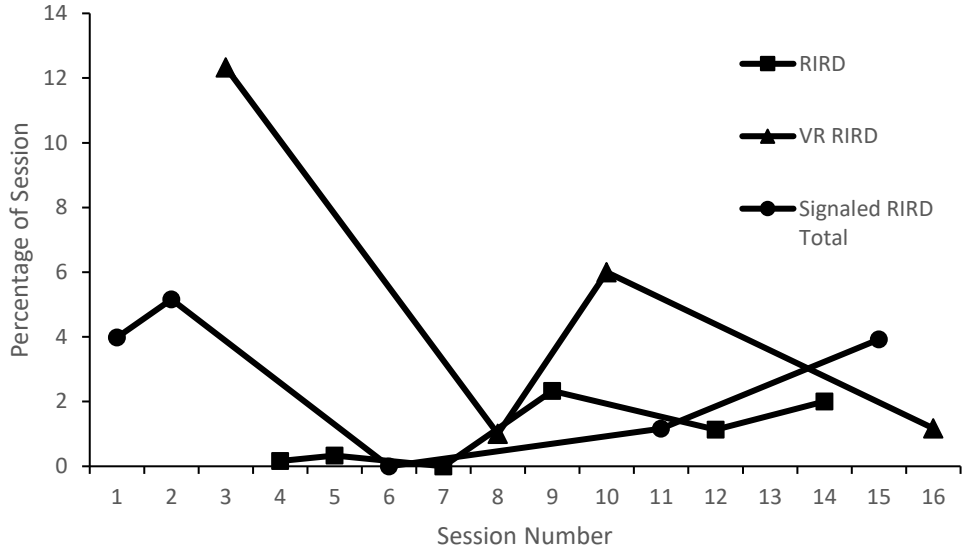

Figure 14. Motor stereotypy during the treatment evaluation (occurrences of vocal stereotypy when the green card was absent during the Signaled RIRD condition) for Krishna.

Nandan

Figure 15 displays the results of the treatment evaluation in terms of engagement in vocal stereotypy (Figure 15 includes the total stereotypy that occurred during the Signaled RIRD condition [i.e., data include responding that occurred in the presence *and* absence of the green card]). Percentages of vocal stereotypy were highest during the VR RIRD condition (M = 28.27%) relative to the RIRD (M = 13.63%) and Signaled RIRD (M = 2.44%) conditions. The results of the VR RIRD condition were clearly differentiated from both the RIRD and Signaled RIRD conditions. When the results of the evaluation included only those instances of stereotypy that occurred when the green card was absent (Figure 16), the results of the evaluation were

initially undifferentiated, but vocal stereotypy eventually decreased in the Signaled RIRD condition (*M* = 12.96%) relative to the VR RIRD and RIRD conditions.

Figures 17 displays the results of the treatment evaluation in terms of engagement in motor stereotypy (Figure 17 includes the total stereotypy that occurred during the Signaled RIRD condition [i.e., data includes responding that occurred in the presence *and* absence of the green card]). Percentages of motor stereotypy were highest during the Signaled RIRD condition (*M* = 1.59%) relative to RIRD (*M* = .27%) and VR RIRD (*M* = .43%) conditions. The results of the evaluation were lower when data in the Signaled RIRD condition (*M* = .47%) included only those instances of stereotypy that occurred when the green card was absent (Figure 18).

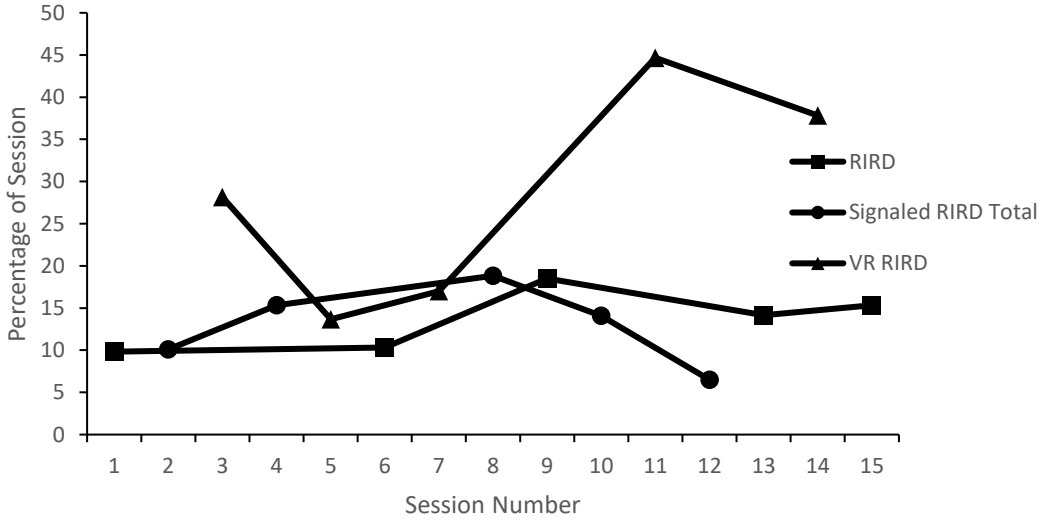

Figure 15. Vocal stereotypy during the treatment evaluation (occurrences of vocal stereotypy that occurred during the entire session in the Signaled RIRD condition [i.e., regardless of the presence or absence of the green card]) for Nandan.

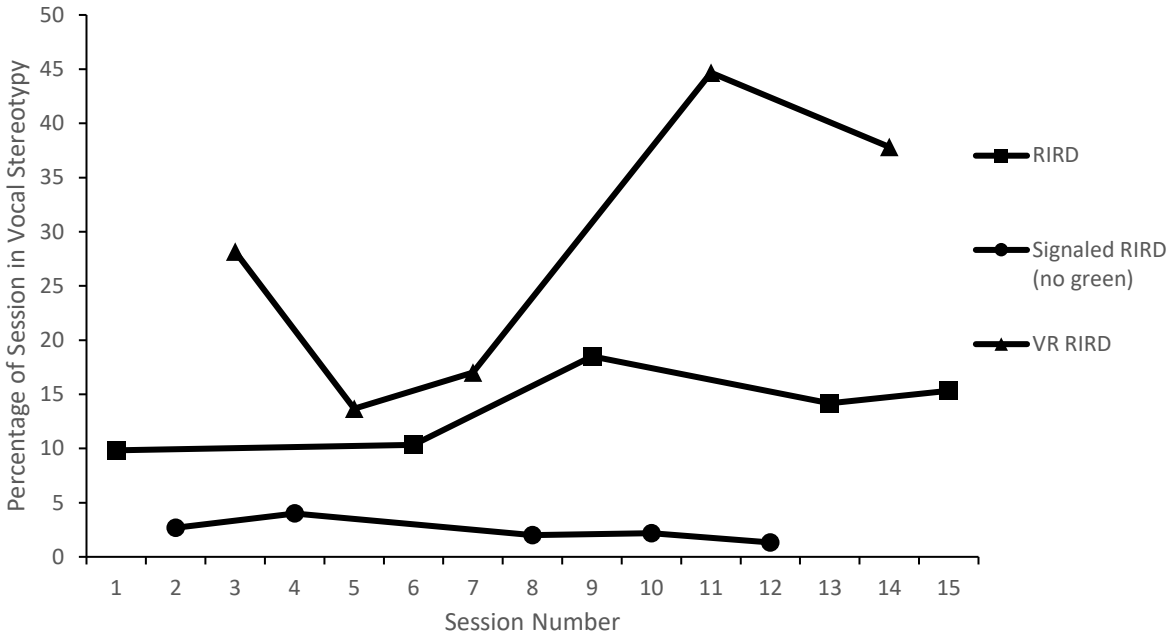

Figure 16. Vocal stereotypy during the treatment evaluation (occurrences of vocal stereotypy when the green card was absent during the Signaled RIRD condition) for Nandan.

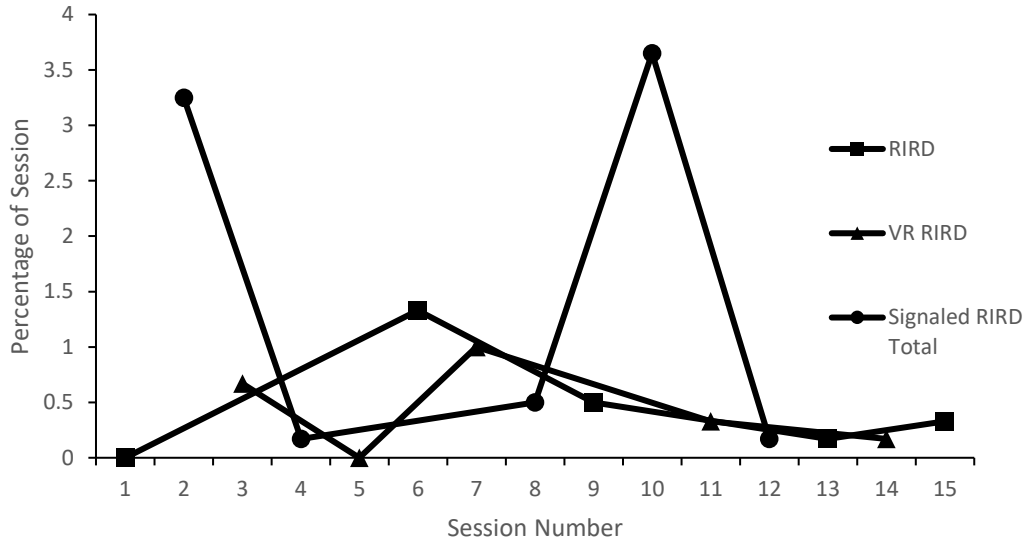

Figure 17. Motor stereotypy during the treatment evaluation (occurrences of vocal stereotypy that occurred during the entire session in the Signaled RIRD condition [i.e., regardless of the presence or absence of the green card]) for Nandan.

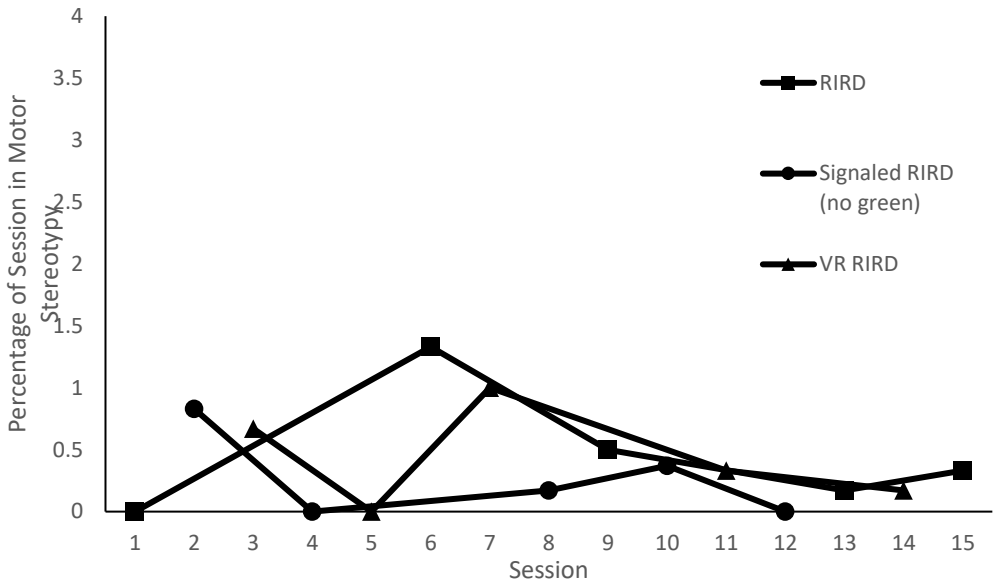

Figure 18. Motor stereotypy during the treatment evaluation (occurrences of vocal stereotypy when the green card was absent during the Signaled RIRD condition) for Nandan.

Chapter 5: Discussion

Functional analyses were conducted to evaluate variables maintaining vocal and motor stereotypy exhibited by individuals diagnosed with an autism spectrum disorder. Results for all participants suggested that stereotypy was maintained by automatic reinforcement. Furthermore, the results for Raja and Nandan's vocal stereotypy indicated differentiated patterns of behavior (i.e., vocal stereotypy occurred primarily in the alone and play conditions), while undifferentiated results were obtained with regard to Raja and Nandan's motor stereotypy and all of Krishna's stereotypy (i.e., stereotypy occurred across all functional analysis conditions). Following the functional analyses, an experiment was conducted to evaluate and compare the effects of RIRD, Signaled RIRD, and VR RIRD on the occurrence of vocal and motor stereotypy. The primary finding was that Signaled RIRD produced the greatest reductions in stereotypy for all participants relative to both VR RIRD and RIRD. The highest amount of stereotypy occurred during the VR RIRD conditions across all participants.

With regard to the Signaled RIRD condition, engagement in stereotypy was expected to be higher during times in which the green card was present (i.e., indicating that RIRD was not in place) than times in which the green card was absent (i.e., indicating that RIRD was not in place). Within-session analyses indicated that stereotypy totals were consistently lower during the Signaled RIRD condition when engagement that occurred when the green card was present (i.e., the cue that RIRD was not in place) was not included in the total amount of engagement. Percentages of engagement increased when the results included behavior that occurred in the presence and absence of the green card. Given that more stereotypy occurred in the presence of the green card than the absence of the green card, it may be inferred that stimulus control was

established with the green card in terms of stereotypy. Within-session data analysis suggested that stereotypy occurred more often in the presence of the green card across all participants. Furthermore, engagement in stereotypy also decreased in the absence of the green card relative to the RIRD and VR RIRD conditions.

Potential Clinical Implications

The Signaled RIRD condition showed greater reduction in stereotypy than the RIRD and VR RIRD conditions. Thus, the current results pertaining to Signaled RIRD were similar to and extended the findings of Sloman et al. (2017). Specifically, Sloman et al. demonstrated that consistent implementation of Signaled RIRD decreased stereotypy as well as the total amount of implementation time of RIRD. For all three participants in the current study, overall decreases in engagement in both stereotypy and implementation time of RIRD were anecdotally observed. In fact, Krishna's stereotypy decreased to 0 instances along with 0 instances of implementation of RIRD during times in which the green card was absent (i.e. times when RIRD was implemented contingent on each instance of stereotypy) during the last three Signaled RIRD sessions. Raja's vocal stereotypy also decreased to 0 instances during times in which the green card was absent during the fourth and fifth sessions of Signaled RIRD. Raja also had 0 instances of vocal stereotypy and implementation of RIRD during the fourth session of the Signaled RIRD condition when total data collection was utilized (i.e. occurrences of vocal stereotypy were totaled for the entire session of the Signaled RIRD condition regardless of the presence or absence of the green card). When the Signaled RIRD intervention was implemented with Nandan, he began to show a steady decreasing overall trend in engagement of both motor and vocal stereotypy with a slight increase in motor stereotypy during the fourth session of Signaled RIRD; while vocal stereotypy

simultaneously decreased during the fourth session of Signaled RIRD. Neither the RIRD or VR RIRD conditions resulted in zero-levels reductions of stereotypy for either Nandan or Raja. For Krishna, zero levels of stereotypy were observed in one session of RIRD and one session of VR RIRD; on both occasions the session immediately before and after the session that had zero instances of stereotypy had higher than average engagement in vocal stereotypy. The RIRD and VR RIRD sessions that had zero instances of vocal stereotypy were not a part of an overall decreasing trend. Krishna also continued to engage in motor stereotypy during those sessions in which he engaged in no vocal stereotypy. Thus, taken together, the results of Sloman et al. (2017) and the current study suggest that Signaled RIRD may be a promising approach to the treatment of stereotypy relative RIRD and/or VR RIRD.

To date, all studies on RIRD have utilized a 1:1 ratio in terms of researcher-to-participant (i.e., Ahearn et al., 2007; Ahrens et al., 2011; Carroll & Kodak, 2014; Cassella et al., 2011; Dickman et al., 2012; Lui-Gitz & Banda, 2010; Love et al., 2012; Martinez et al., 2016; Pastrana et al., 2013; Saini et al., 2015; Schumacher & Rapp, 2011; Shawler & Miguel, 2015; Sloman et al., 2017). These previous studies also included highly trained professionals who implemented the RIRD intervention. No studies have evaluated the effectiveness of RIRD when it is implemented in contexts in which the child is in a higher ratio setting or when less qualified professionals or parents are implementing the procedures. Thus, finding a procedural variation of RIRD (e.g. Signaled RIRD) that may reduce the need for a 1:1 ratio could have significant clinical implications in terms of the generality and feasibility of the procedure in other settings such as school and home. The results of the current study, along with Sloman et al. (2017), suggest that utilizing stimulus control procedures within the the Signaled RIRD arrangement

may be beneficial in such settings. Future studies should extend the current results by evaluating these procedures in natural settings in which ratios of child-to-care provider are higher than 1:1 and implementers are not trained researchers.

During this study, engagement in stereotypy decreased in the absence of the green card relative to the RIRD and VR RIRD conditions. The procedures that were implemented in the absence of the green card were identical to those used in the RIRD condition yet, additional reductions were observed during the Signaled RIRD condition when the green card was present (indicating the absence of RIRD contingent on stereotypy) that were not observed in the RIRD condition. While the answer to the question as to why this might have been the case within the context of this study, it may be that by allowing the child designated times to engage in stereotypy without consequence, their need or motivation to engage in it during undesignated times may have lowered. An individual engages in automatically maintained stereotypy because it is intrinsically reinforcing to them. Consistently denying them the ability to engage in the behavior may inadvertently increase the frequency at which an individual engages in it as they attempt to gain access to that intrinsic reinforcement. Giving the individual a cue as to when they are allowed to engage in the automatically maintained behavior without consequence and a cue as to when consequences will be implemented may give the individual the motivation they need to inhibit the stereotypy for brief periods of time.

EXTENSIONS TO THE RIRD LITERATURE

The results of this study extend the literature pertaining to the treatment of automatically maintained stereotypy in several ways. First, this study found that Signaled RIRD was the most effective intervention at reducing both motor and vocal stereotypy across all participants.

Previous research has shown that Signaled RIRD can be effective at reducing vocal stereotypy (i.e., Sloman et al., 2017). Further, the current study is the first, to our knowledge, that evaluated Signaled RIRD as an independent variable in terms of its effects on motor stereotypy. Also, the current study is the first, to our knowledge. to compare the effects of Signaled RIRD with RIRD and VR RIRD. Thus, the current study extends the literature by showing that not only can Signaled RIRD be utilized effectively to decrease both motor and vocal stereotypy, but it may be a more effective strategy than RIRD alone as well as intermittently implemented RIRD (i.e., VR RIRD).

Second, previous research on automatically maintained behaviors has suggested that the response strength for differentiated behaviors is less than that of undifferentiated behaviors (Catania, 1979). Cannella (2005) suggested that this may result in the necessity of additional time and patience for individuals who engage in automatically maintained behavior that is undifferentiated because it may take longer to observe the effects due to greater response strength. In the current study, Raja and Nandan's vocal stereotypy occurred in differentiated patterns during the functional analysis; further, Raja and Nandan's motor stereotypy as well as Krishna's vocal and motor stereotypy indicated undifferentiated patterns. Despite four out of six of the behaviors being undifferentiated in this study, there were no differences in the pattern of responding to the intervention across participants. Thus, these results extend the literature by suggesting that, at least in the case of the current vocal and motor stereotypy, there may not be a difference in response strength between differentiated and undifferentiated behaviors. Future studies should continue to explore possible interactive effects between differentiated and undifferentiated patterns of responding (in terms of the results of functional analyses) and response to treatment.

Third, Carroll and Kodak (2014) utilized interrupted and uninterrupted data collection measures as independent variables to determine whether the way RIRD data were collected impacted the outcome of the intervention. In Carroll and Kodak, interrupted data collection measures included data collected outside of RIRD implementation only (i.e. all stereotypy that occurred while implementing RIRD did not count towards the data); uninterrupted data collection included the total amount of stereotypy from the entire session (i.e. all stereotypy counts towards the data whether it occurred during RIRD implementation or not). Carroll and Kodak found that when interrupted data collection was utilized the results were drastically lower (i.e., near-zero levels) when compared to uninterrupted data which rendered results suggesting little effect at all when RIRD was implemented. The current study utilized uninterrupted data collection for all conditions; in addition, the current studies utilized a variation of interrupted data collection measures during the Signaled RIRD conditions to evaluate possible stimulus control effects. The results of the current study contradict those of the Carroll and Kodak. When utilizing interrupted data collection measures for Signaled RIRD, there were minimal differences between the engagement in stereotypy compared to uninterrupted data collection. Thus, this study expands the current literature on interrupted and uninterrupted data collection measures for RIRD by suggesting that utilizing interrupted data collection measures may not skew the results of RIRD procedures to indicate they are more effective as much as previously thought.

Last, previous research has shown that intermittent schedules of punishment produce greater persistence to the suppression of the behavior (Deur & Parke, 1970; Estes, 1944; Jones, 1953). Research has also shown that intermittent schedules have shown positive but inconsistent effects in applied research (e.g., Lerman, Iwata, Shore, & DeLeon, 1997; Tarbox et. al., 2002). In

the current study, VR RIRD conditions showed the highest percentage of engagement in both vocal and motor stereotypy. Thus, this study provides preliminary evidence that despite research showing variable-ratio of punishment arrangements can be effective at decreasing maladaptive behaviors, this may not be the case with vocal and motor stereotypy. Thus, the current results extend the literature on variable-ratio of punishment arrangements by (a) being the initial study to evaluate a variable ratio of punishment schedule to address stereotypy and (b) showing that a variable ratio of punishment may not be potent enough to decrease automatically maintained stereotypy. Future studies should continue to evaluate the effects of variable ratio-based punishment procedures in terms of their effects on maladaptive behaviors when clinical situations call for the use of punishment procedures (i.e., reinforcement-based approaches are exhausted with minimal effect).

FUTURE DIRECTIONS

RIRD can create emotional responding due to the blocking of the stereotypy and requirement to engage in a series of tasks (Kornedor, 2014). In the current study, while data were not explicitly collected on emotional responding, a clear correlation between the implementation of RIRD and an increase in aggression and tantrums was anecdotally observed in two of the three participants. It is important to note that these two participants were indicated by parents and therapists to have a history of engagement in aggression and tantrum behavior; while the third participant did not have an history of engagement in problem behavior indicated. Future research should evaluate the potential side effects (e.g., negative reactions/behaviors; negative emotional responses) of RIRD, if/how such side effects might relate to histories of engagement in problem behaviors, and if/how such side effects may affect the outcomes of RIRD procedures.

Most research on discrimination training has been conducted during preferred activities with no demands present (e.g., Ahearn et al., 2007, Ahrens et al., 2011; Athens et al., 2008, Cassella et al., 2011; Martinez & Betz, 2016). In the current study, both Krishna and Nandan's sessions each occurred only in the presence of preferred activities. For Raja, however, due to the severity of his behaviors and his lack of ability to engage in any one activity for more than a few minutes (including play), his sessions were split between his typical applied behavior analysis (ABA) programming demands and play. While data were not explicitly collected on maladaptive behaviors, the lead researcher noted anecdotally, that Raja did engage in less non-targeted maladaptive behaviors (i.e. aggression, property destruction, eloping) during the demand portion of the session than the play portion. Levels of stereotypy were the same across, within and across sessions, regardless of activity. While all activities done during each participants' sessions included activities that they experienced in their day-to-day lives in their school/clinic with typical peers, all of the participants in the current study experienced 1:1 (i.e. no typical peers or teachers were present) ratios in a more analogue environment during the intervention evaluation. Sloman et al. (2017) was the first study to evaluate Signaled RIRD during demands and activities the child would typically encounter throughout their day with both peers and teachers present. Sloman et al.' results were promising in that decreases in stereotypy were observed with their participant. However, to our knowledge, no other studies have evaluated Signaled RIRD in a more typical, naturalistic setting. Future research should continue to investigate the effectiveness and feasibility of implementing Signaled RIRD in typical settings. Future research should also evaluate the effectiveness of RIRD procedures in terms of generalization to typical care providers (e.g., teachers and parents) for implementation.

Sloman et al. (2017) is the only study to date that has implemented a control session for Signaled RIRD that tested the effectiveness of the stimulus cue in the absence of RIRD as a consequence for stereotypy. Results showed that when the stimulus cue was presented in the absence of RIRD during deskwork there was a slight decrease in stereotypy initially. There was no effect when in the community setting. Future research should further investigate the effects of the stimulus cue to determine whether the cue alone may gain stimulus control over the stereotypy without requiring a consistent punishment procedure (e.g., indiscriminable contingencies; Stokes & Baer, 1977).

As previously mentioned, engagement in stereotypy decreased in the absence of the green card relative to the RIRD and VR RIRD conditions. These results cannot be explained within the context of this study. Future research should further investigate this phenomenon to determine why stereotypy may show further decreases during the absence of the green card in Signaled RIRD despite having the same procedures as RIRD. Future research should also (a) compare Signaled RIRD to other procedural variations of RIRD, (b) increase the intervals in which RIRD (and the corresponding cue) is absent to more age-appropriate times for the child, (c) further investigate interrupted and uninterrupted data collection measures in relation to RIRD, and (d) utilize RIRD to address visual stereotypy in addition to vocal and motor stereotypy.

LIMITATIONS

While the current results of this study are promising, they should be considered while noting some potential limitations. First, the demonstration of stimulus control for Signaled RIRD sessions was not formally addressed within this study. Control sessions were not included to test stimulus control by presenting the cue in the absence of programmed consequences (i.e.

presenting the green card without RIRD as a consequence for stereotypy). Thus, we cannot determine if the green card successfully gained stimulus control over the stereotypy resulting in the noticeable decreases or if there were other factors at play during the Signaled RIRD sessions.

Second, Signaled RIRD in this study was only implemented in 1-min increments (i.e. green card alternated between being present and absent on a 1-min schedule). Thus, for each 10-min session, the green card was present for a total of 5 min and absent for a total of 5 min. Alternating a card to allow a child to engage in stereotypy on such a dense schedule is not realistic in a school or home setting and would require a constant 1:1 ratio to implement. The intervals during which the green card is present and absent would need to be greatly increased to more manageable time frames to show generality and feasibility in a natural setting. Increasing to allow the absence of the green card for up to 30 min would allow for a child to experience more benefits of the natural environments (e.g. engagement in an entire lesson at school, an entire circle time, or the length of recess without engaging in stereotypy) and learn to have the ability to refrain from engaging in stereotypy for more age-appropriate amounts of time.

Lastly, there is no standardized approach to identifying or operationally defining vocal and motor stereotypy for each of the participants. To date the field of ABA utilizes individualized definitions of each behavior and does not have a standardized assessment available to determine whether the child's specific behavior is or is not considered stereotypy. Instead, there is a universally accepted definition of stereotypy in that a behavior that is repetitive, rigid, has invariance, and has no apparent function on the environment (Turner, 1999) can be considered a stereotypy. If the provider or researcher deems that the child's specific behavior fits that description, they then create an individualized operational definition based on

the topography of that specific child's behavior. Thus, it is possible that no two operational definitions for an individual's stereotypy are the same. The implications of this will need to be investigated in future research.

CONCLUSION

In conclusion, while there is still much research to do regarding RIRD and stereotypy, the results of this intervention were positive and promising. It was observed that there was no difference in stereotypy when the session included all play, or both demands and play. This is likely because all the participants had automatically maintained stereotypy as determined by a functional analysis conducted prior to implementation of the intervention. If the participants stereotypy served an escape or attention function, then the results of the study may have been different and alternative methods or treatment packages may have been required to achieve the same results. It was also observed that RIRD triggered an increase in aggression in two participants. Despite the increase in aggression, RIRD and Signaled RIRD conditions still resulted in decreases in stereotypy. All three participants showed the most reduction in their engagement in stereotypy during Signaled RIRD and the least reduction during VR RIRD. These findings suggest that the addition of treatment components to RIRD (e.g. adding discrimination training to RIRD for Signaled RIRD) may increase the effectiveness of the intervention. Additionally, implementing RIRD in a less consistent manner (i.e. variable ratio) may not be as effective in reducing automatically maintained stereotypy. More research is needed on Signaled RIRD and VR RIRD to confirm these results, but this study produced beneficial results to guide future studies.

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